# THE OTHER-RACE EFFECT IN FACE PERCEPTION AND RECOGNITION: CONTRIBUTIONS OF SOCIAL CATEGORISATION AND PROCESSING STRATEGY

by

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# ABSTRACT

The other-race effect refers to the impoverished individuation and recognition of other-race faces relative to own-race faces. The aim of this thesis was to investigate non-racial ingroup/outgroup categorisation, inter-/intra-racial context, and encoding conditions as signalling cues that affect own- and other-race face processing. Across eight experiments using both behavioural and neuroimaging methods, I demonstrated (1) that the context in which own- and other-race faces are encountered can determine the salience of racial category membership, with implications for how (and how much) non-racial ingroup/outgroup status influences own- and other-race face perception, (2) that task demands can lead perceivers toward more or less configural processing regardless of target ingroup/outgroup status, with implications for the influence of non-racial ingroup/outgroup status, and (3) that both racial and non-racial ingroup/outgroup status have the potential to influence the early stages of face perception. These findings both support and extend the Categorisation–Individuation Model, yielding a more comprehensive insight into the other-race effect.

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# CHAPTER 1

# "THEY ALL LOOK ALIKE TO ME": THE OTHER-RACE EFFECT

*This chapter introduces the other-race effect, or the common observation that people find it especially difficult to discriminate between, and display impoverished recognition for faces of a different race from their own, relative to faces of their own-race. The literature review details potential mechanisms underlying the effect, and highlights several influential theoretical models of the other-race effect, culminating with the recently proposed Categorisation–Individuation Model. The review details the model's assumptions, reviews supportive evidence, and highlights limitations and areas for theoretical advancement. The chapter ends with a discussion of the aims and hypotheses of the thesis and an overview of the general methodological approach.*

## 1 Introduction

> "…It is well known that, other things being equal, individuals of a given race are distinguishable from each other in proportion to our familiarity, to our contact with the race as a whole. Thus to the uninitiated American, all Asiatics look alike, while to the Asiatic all White men look alike…" (Gustave A. Feingold, 1914)

"They all look alike to me". This uncomfortable, but not uncommon, impression is often what people experience when confronted with members of ethnic groups other than their own (Meissner & Brigham, 2001a; Meissner, Brigham, & Butz, 2005; Sporer, 2001). Indeed, the reduced individuation of other-race relative to same-race faces has been of concern for psychologists for nearly a century (e.g., Feingold, 1914), as it can have important negative consequences both for the perceiver and the target. For the perceiver, mere feelings of social embarrassment at not being able to recognise other individuals; for the target, the potentially life changing, as in cases of eyewitness misidentification that lead to criminal conviction and prison sentencing (Brigham, Bennett, Meissner, & Mitchell, 2007). Such reduced individuation can also maintain heightened levels of intergroup conflict and mistrust, and cognitive processing biases begin to inform stereotypes during the perception of other individuals (Brigham & Malpass, 1985). For example, other groups are perceived as more homogenous than the individual's own group (Linville, Fischer & Salovey, 1989; Linville & Jones, 1980; Quattrone & Jones, 1980). Intergroup interactions therefore become less rewarding and more difficult due to the likelihood of making recognition errors (Brigham, 2008). Avoiding such inter-racial interactions, however, only maintains perceptions of other-race homogeneity. The clear importance of this own-race advantage in individuation has therefore motivated a profusion of attempts to identify its causes, cumulating in several theoretical models of the "other-race effect" (e.g., Meissner & Brigham, 1985). These accounts can be more broadly divided into perceptual expertise based explanations, or feature-based accounts of the other-race effect.

These accounts differ in the proposed locus of the other-race effect, but say little about possible interactions between perceptual experience and social categorisation or the specific aspects of face processing that may be affected by these factors. Broadly, this thesis examines the relative weightings between social-motivation and perceptual experience (i.e., race-specific processing experience) in determining memory and processing outcomes in the other-race effect at the behavioural and electrophysiological level. I examine how racial context and encoding goals influence the relative weightings of these factors. I begin by introducing the other-race effect in more detail and outline the memory and processing, correlates of racial biases in face memory and processing.

# 2 The Other-Race Effect

The other-race effect, interchangeably referred to as the *own-race bias*, *cross-race effect*, and the c*ross-race recognition deficit*, refers to the finding that discrimination and recognition accuracy tend to be impoverished for other-race, relative to own-race, faces (Ayuk, 1990; Brigham, & Barkowitz, 1978; Barkowitz & Brigham, 1982; Cross, Cross, & Daly, 1971; Chance & Goldstein, 1981; Chance, Goldstein, & McBride, 1975; Ellis & Deregowski, 1981; Goldstein & Chance, 1980; Lindsay, Jack, & Christian, 1991; Malpass & Kravitz, 1969). The effect remains one of the most replicated findings within the face perception literature. (For reviews, see Brigham, 2008; Brigham et al., 2007; Brigham, 1986; Brigham & Malpass, 1985; Chance, & Goldstein, 1996; Sporer, 2001).

Several meta-analyses have examined the other-race effect (Anthony, Copper, & Mullen, 1992; Bothwell, Brigham, & Malpass, 1989). Meissner et al. (2001a) analysed data from 39 research articles, involving 91 independent samples and nearly 5,000 participants and focused on recognition sensitivity, as calculated within a signal detection framework. In brief, signal detection postulates that during face recognition experiments, participant's responses are generated either by the *signal* (i.e., familiarity/memory for a target face) or are generated by *noise* (i.e., occur due to chance or misattributed familiarity for a new/foil face; e.g., Green & Swets, 1966; Macmillan & Creelman, 1991). Correct identification of target faces produces a "hit", and inappropriately identifying a foil face as a target produces a "false alarm". By calculating the sum of hits and false alarms, signal detection produces an estimate of the signal strength relative to noise (*d'*), and can be utilised to calculate response strategy/bias (*C*). Measures of response bias reflect the overall strategy employed by participants when making old/new judgements. Participants can either exhibit a liberal response bias (i.e., responding incorrectly that a target face is present when it is actually absent), a conservative response bias (i.e., incorrectly responding that a target is absent, or committing a "miss"), or no bias (Macmillan & Creelman, 1991). In terms of the other-race effect, Meissner et al.'s meta-analysis demonstrated several findings of interest. Firstly, the other-race effect was robust, accounting for 15% of the variability across all studies. Secondly, a significant "mirror" effect was observed, characterised by a pattern whereby other-race faces received a lower proportion of "hits" (i.e., other-race targets were less likely to be correctly identified as a target, relative to own-race targets), and a higher proportion of false alarms (i.e., other-race foils were incorrectly identified as targets more, relative to own-race foils). Consistent with this mirror effect, Meissner et al. also found evidence for differential response biases to own-race and other-race faces. Own-race faces were associated with a more conservative response bias (i.e., incorrectly responding that a target is absent more often, or committing more "misses"). In contrast, other-race faces were associated with a more liberal response bias (i.e., responding incorrectly that a target face is present more often when it is actually absent); however, this accounted for less than 1% of the overall variance across studies (Meissner & Brigham, 2001a). These differences in response strategy may reflect attention differences modulating *recollection* and *familiarity* processes in participants' judgements (Macron, Susa, & Meissner, 2009). For example, it may be that we actually recollect own-race faces (i.e., remember them) more, where as for other-race faces we rely mere feelings of familiarity (i.e., he seems familiar; Meissner et al., 2005). Overall, the data presented thus far suggests that own-race faces are processed either more efficiently or in a qualitatively different way to other-race faces, a point to which I will return in subsequent sections.

Other-race effects are not exclusive to White individuals; indeed, other-race effects have been observed using various ethnic groups as participants, such as Hispanic (e.g., Gross, 2009, Platz & Hosch, 1988; MacLin, MacLin, & Malpass, 2001), East Asian (e.g., Chance, Goldstein, & McBride, 1975; Chance, Turner, & Goldstein, 1982; Goldstein & Chance, 1980; Gross, 2009, Luce, 1974; Ng & Lindsay, 1994, Michel, Caldara, & Rossion., 2006; Sangrigoli, Pallier, Argenti, Ventureyra, de Schonen, 2005), Black (e.g., Ellis & Deregowski, 1981; Gross, 2009), and Middle Eastern participants (e.g., Megreya, Burton, & White, 2011). Therefore, the other-race effect therefore transcends racial group membership.

The aforementioned paragraph may lead the astute reader to believe the other-race effect is explained entirely by majority or minority group status within a given country. This assumption, however, would be inaccurate. Other-race effects have been observed in both majority and minority groups (Gross, 2009; Platz, & Hosch, 1988; Wright Boyd, & Tredoux, 2001, 2003). For example, in a classical field study of the other race-effect, Platz and Hosch (1988) examined the performance of Mexican, Black, and White convenience store workers in the United States in identifying customers (in reality, confederates) of these same three ethnicities. Customers had interacted with the workers earlier in the day (for example, by asking for directions) or made memorable transactions (for example, by paying in pennies). Two hours later, two more confederates, posing as law interns, asked the convenience store workers for help in identifying customers who may have entered the store that day. Platz and Hosch observed a significant other-race effect, with each group recognising faces of their own-race better than faces from any other ethnic group. More recently, Gross (2009) had participants representative of the four major ethnic groups within the USA (White, Black, East Asian, and Hispanic) perform a recognition task with faces of each ethnic group and objects. Data were analysed with object recognition scores as a covariant, essentially controlling idiocentric differences in visual recognition. Critically, all participants exhibited an own-race bias at recognition; this was irrespective of majority or minority group status. However, all ethnic groups did exhibit greater recognition for White (i.e., the majority group within the USA), after their own race, with the exception of Black participants who exhibited equal recognition of Black and White faces. Therefore, the other-race effect transcends minority/majority group status.

Finally, although Meissner et al. (2001a) included in their meta-analysis a vast majority of studies conducted within the USA and Canada (around 85; Meissner et al., 2001a; Brigham, 2008; Brigham et al., 2007), it would be a misapprehension to assume that the effect is restricted to North America. Indeed, the other-race effect has been replicated across many different countries. For example, other-race biases have been evident both in South Africa and the United Kingdom (e.g., Chiroro & Valentine, 1995, Walker, & Hewstone, 2006a; Wright, Boyd, & Tredoux, 2001, 2003), as well as other European nations such as Germany (e.g., Sporer, 2001; Tanaka, Kiefer, & Bukach, 2004), Middle Eastern nations such as Egypt (e.g., Megreya, Burton & White, 2011), and Eastern cultures (e.g., Ng & Lindsay, 1994). The other-race effect, therefore, transcends differences in culture.

In conclusion, the other-race effect is a robust phenomenon that transcends race, culture, and minority/majority group status. Consequently, the other-race effect cannot be explained by simple differences between these variables, but instead reflects a more general bias in the way we encode, perceive or remember people that are from different ethnic groups than our own.

# 3 Theoretical Approaches: *Why* the Other-Race Effect Occurs

Given the overwhelming importance and pervasiveness of the other-race effect, several theoretical accounts have been proposed in the literature, with varying degrees of explanatory success. Early approaches alleged that the effect is explained by physiognomic differences between disparate race faces, or by racial prejudice. Expertise accounts, in contrast, generally propose that the effect is a consequence of limited perceptual experience with other-race faces. Finally, attentional accounts assert the other-race effect derives from a tendency to pay less attention to, or disregard other-race individuals, rather than derived from perceptual experience per se.

**3.1 Early Approaches: Homogeneity and Racial Prejudice**

One of the earliest explanations of the other-race effect was that other-race (i.e., non-White/Caucasian) faces are more or perceived to be more physiognomically homogenous (e.g., Malpass & Kravitz, 1969). Accordingly, discrimination between and recognition of other-race faces are impaired relative to White face recognition. Researchers investigating physiognomic homogeneity have found very little evidence to support their hypotheses. Indeed, this line of enquiry is substantially undermined by the overwhelming evidence demonstrating that the impoverished recognition for other-race faces, but unimpaired recognition for own-race faces, occurs across various ethnic groups (see previous sections). For example, other-race individuals (i.e., non-White individuals) display superior recognition of their own racial group relative to other-racial groups (e.g., Brigham & Barkowitz, 1978; Byatt & Rhodes, 2004; MacLin & Malpass, 2001; Chance et al., 1982; Chance, Goldstein, & McBride, 1975; Goldstein, & Chance, 1980; Gross, 2009; Luce, 1974; Ng & Lindsay, 1994; O'Toole, Deffenbacher, Valentine, & Abdi, 1994; Platz & Hosch, 1988; Sangrigoli et al., 2005; Valentine & Endo, 1992). Observations that non-White participants find it difficult to recognise White faces generally undermines an explanation of the other-race effect based exclusively on White faces having more physiognomic variability than non-White faces.

Experiments directly investigating physiognomic homogeneity have failed to provide any plausible evidence in support of the accounts assumptions. Anthropological measures show no support of racial homogeneity. For example, Goldstein and Chance (1979a, 1979b) examined anthropological measurements in White, Japanese, and Black faces (taken from previous research). The authors concluded there was no plausible evidence for racial differences in facial heterogeneity (i.e., all of the different racial faces tested exhibited similar amounts of facial variability).

Psychological experiments have also been unsuccessful in establishing any credible evidence for within-racial group homogeneity (e.g., Goldstein & Chance, 1976, 1978; but see Goldstein & Chance, 1979c, for contrasting evidence). For example, Goldstein and Chance (1976) used a perceptual same/different paradigm with pairs of own- or other-race faces; their reasoning was that if other-race faces really are more homogenous, then White participants should show longer reaction times and produce more errors when making same/different judgements to other-race faces. Results demonstrated that both reaction times and accuracy rates did not differ as a function of stimulus race. In a follow-up study, Goldstein and Chance (1978) had White and East Asian participants perform a task where they judged whether pairs of White or pairs of East Asian faces were more or less similar to each other. Again, the results failed to establish any difference in participants' average judgements as a function of race.

In conclusion, there is no compelling evidence that the other-race effect is accounted for by racial differences in physiognomic homogeneity. However, as Meissner and Brigham (2001a) note, different physiognomic features may be more appropriate for discriminating between and recognising own-race—but not other-race faces (Bar-Haim, Saidel, & Yovel, 2009; Ellis, Deregowski, & Shepherd, 1975; Shepherd, 1981; Shepherd & Deregowski, 1981).

A second early explanation of the other-race effect was that the bias reflected an individual's racial prejudice. Otherwise stated, people with more prejudiced attitudes would be less motivated to differentiate between other-race faces. Nevertheless, explicit measures of prejudice have consistently failed to corroborate any relationship between the magnitude of the other-race effect in memory and participants' racial prejudice (Brigham & Barkowitz, 1978; Lavrakas, Buri, & Mayznerm 1976; Platz & Hosch, 1988; Slone, Brigham, & Meissner, 2000). Nor does evidence emerge when implicit measures are used. In a recent study, Ferguson, Rhodes, Lee, and Sriram (2001) used a priming procedure (after Fazio, Jackson, Dunton, & Williams, 1995) whereby they presented participants with a list of adjectives, each of which was preceded by either an own- or other-race face. Participants had to decide as quickly as possible whether each word had a positive or negative connotation. In this procedure, the degree to which faces facilitate the judgements of positive or negative words indicates a participants' attitude towards a target race (Fazio et al., 1995). Specifically, faster responding to negative adjectives when preceded by an other-race face than an own-race face, and slower responding to positive words when preceded by an other-race face than an own-race race, indicates a negative attitude towards the other racial group. Following this priming procedure, participants completed an old/new recognition test, where the old/target faces were the same faces employed in the priming task. Ferguson et al. observed no evidence that implicit prejudice (as indexed by priming effects) influenced the magnitude of the other-race effect. In conclusion then, there is no credible evidence suggestive of prejudice underpinning the other-race effect. This is substantiated by Meissner and Brigham's (2001a) meta-analysis, which found no direct link between level of prejudice and other-race recognition.

### 3.2 Expertise/Perceptual Familiarity Accounts

Expertise accounts, in general, propose that perceivers are more familiar/experienced with own-race than other-race faces and consequently process own-race faces more accurately and efficiently than other-race faces (e.g., Brigham & Malpass, 1985; Goldstein & Chance, 1985, Kelly et al., 2007a), the result of which is substantially improved recognition for own-race relative to other-race faces. According to this account, the greater contact that perceivers have with members of their own racial group leads them to become substantially more sensitive to the facial features and cues of their own race, allowing them to successfully differentiate between countless numbers of disparate own-race faces (Byatt & Rhodes, 2004; Chiroro & Valentine, 1995; Corenblum & Meissner, 2006; Furl, Phillips, & O'Toole, 2002; Hills & Lewis, 2006; Valentine, 2001; Walker & Hewstone, 2006a).

In essence, the expertise hypothesis implies that the magnitude of the other-race effect reflects the amount of inter-racial experience one has had with a given race. Consequently, the other-race effect should be most evident in individuals who either have had no, or very limited, experience with other-race faces; in contrast, the other-race effect should be absent or weak for those with high levels of inter-racial experience. Three lines of enquiry are generally cited as supporting this reasoning: adoption studies (e.g., Sangrigoli et al., 2005; De Heering, Liedekerke, Deboni, & Rossion, 2010), developmental studies (e.g., Chance et al., 1982; Ferguson, Kulkofsky, Cashon, & Casasola, 2009; Kelly et al., 2005; 2007a; b; 2009; Sangrigoli & de Schonen, 2004; Walker & Hewstone, 2006a), and studies of intergroup contact (e.g., Brigham, Maass, Snyder, & Spaulding, 1982; Carroo, 1986, 1987; Chiroro & Valentine, 1995; Cross et al., 1971; Larvrakas et al., 1976; Luce, 1974; Malpass & Kravitz, 1969, Ng & Lindsay, 1994; Wright, Boyd, & Tredoux, 2001, 2003).

**3.2.1 Adoption studies.** If experience underlies the other-race effect, then individuals who have had substantial experience with members of other racial groups should display no, or at least a negligible other-race effect. Indeed, individuals who have had more experience with another racial group than with their own might even manifest reversed other-race effects. One such scenario where own-race experience may be limited is after inter-racial adoption. There are at least two notable studies. Sangrigoli et al. (2005) performed a delayed match-to-sample face recognition test with adult Korean participants who had been adopted into White European Families when they were 3–9 years old. The results demonstrated that irrespective of the age of adoption, the adoptees exhibited a strong—but reversed—other-race effect. That is, Korean adoptees recognised White (other-race) faces better than Korean (own-race) faces. These results support the assumption that the other-race effect derives from experience with racial groups—to the point that it is even reversible in childhood, as the face processing system is maturing. It also adds weight to the assertion that experience is pivotal in determining the extent to which we learn the cues that aid own- and other-race discrimination (e.g., Chiroro & Valentine, 1995).

Other evidence suggests that while experience may play a crucial role in learning cues for own- and other-race individuation, it is imperative that that such experience takes place while the face processing system is still evolving (e.g., Carey, Diamond, & Woods, 1980; de Heering et al., 2010). For example, de Heering et al. (2010) investigated recognition accuracy among 6–14-year-old Asian children adopted between two and 26 months of age into White European families. Unlike the results reported by Sangrigoli et al. (2005), de Heering et al. found no reversal of the other-race effect. Nonetheless, recognition was comparable for own-race and other-race faces, suggestive that experience with White faces overrode the emergence of the other-race effect; this effect was not modulated by participant age at adoption. Overall, the results indicate that exposure to own-and other-race faces can modulate own- and other-race face representations while the face system is maturing; even when exposure occurs relatively early (i.e., 2–26 months); however, this may still be insufficient in order to overcome the face representations acquired during very early infancy (e.g., Kelly et al., 2005, 2007a, 2007b, 2009; Quinn et al., 2008; Sangrigoli & de Schonen, 2004).

**3.2.2 Developmental studies.** If experience underpins the other-race effect, then it is possible that the effect follows a developmental trajectory whereby face representations become increasingly more tuned to faces of the perceiver's own race. Chance, Turner, and Goldstein (1982) reported a developmental trend, suggesting that the other-race effect becomes more robust with increasing age. In a recent study, Walker and Hewstone (2006a) tested White primary school (aged 7–11 years), secondary school (aged 12–15 years) and university students to investigate the developmental time course of the other-race effect, using a same/different perceptual matching task (after Walker & Hewstone, 2006b, Walker & Tanaka, 2003). In this procedure, participants viewed either a White or Asian parent face, followed by the same face or a morphed face (created by morphing together a White and Asian parent face over varying degrees along a linear continuum). Participants were instructed to indicate whether the faces were the same or different. Analysis of hits (or when a participant correctly identified the trial type, i.e., same or different) revealed that that while the other-race effect was observed in primary school children (aged 7-11 years), secondary students (aged 12-15) and university students, the magnitude of the other-race effect increased with age. Collectively, this demonstrates that encoding biases in face recognition occur relatively early, and that experience drives a developmental time course whereby face representations become gradually more finely tuned for differentiating between faces of one's own race (Chance & Goldstein, 1982; Ferguson et al., 2009; Furl et al., 2002; Goodman et al., 2007; Walker & Hewstone, 2006a; but see Corenblum & Meissner, 2006; Pezdek, Blandon-Gitlin, & Moore, 2003).

Elsewhere, debate has focused on how early the other-race effect occurs in infancy (e.g., Anzures, Quinn, Pascalis, Slater, & Lee, 2010; Bar-Haim, Ziv, Lamy, & Hodes, 2006; Ferguson et al., 2009; Hayden, Bhatt, Joseph, & Tanaka, 2007; Kelly et al., 2005, 2007a, 2007b, 2009; Quinn et al., 2008). For example, there is evidence that newborn infants show no preference for own- over other-race faces, but by three months old, show a preference for own-race faces, as evidenced by preferential orientating to faces of one's own-race (Kelly et al., 2005). In a more recent study, Kelly et al. (2007a) investigated whether infants also demonstrated an own-race bias in recognition. Kelly et al. utilised a visual-paired comparison task. In this procedure, infants are habituated to a single face, and then exposed to a pair of faces (the habituated face and a new face). If infants orientate towards or look longer at the new face, then this indicates that the infant can discriminate between the old habituated face and the newly presented face. Kelly et al. employed this procedure with 3-, 6- and 9-month-old White infants while they were viewing African, Middle Eastern and Chinese faces. At 3 months, infants discriminated between all faces, irrespective of race; by 6 months of age, infants were only able to discriminate between White and Chinese faces; and by 9 months, discrimination was restricted to own-race faces. These results demonstrate that the other-race effect begins to emerge as early as 6 months of age. Kelly et al. interpreted their results in terms of *perceptual narrowing* (Nelson, 2001), which suggests that the visual system gradually becomes more finely tuned via early experience. Kelly et al. (2007a) suggest that whereas newborn infants are able to distinguish between all faces, their greater experience with own-race faces "tunes" them toward the features that are necessary to differentiate within this category of faces. Taken together, the evidence presented in this section illustrates that early experience in infancy shapes the perceptual face-processing system.

**3.2.3 Inter-racial contact.** According to the contact hypothesis, individuals with less inter-racial experience should exhibit larger own-race recognition biases, whereas those with more experience should show no such effect, or at least a bias towards the category of faces with which one has had the most experience. Such cross-over interactions in racial recognition should therefore be correlated with the respective amount of experience one has with the other-race. Self-report studies, however, are demonstrative of only a weak link between inter-racial contact and the magnitude of the other-race effect (e.g., Brigham, Maass, Snyder, & Spaulding, 1982; Carroo, 1986, 1987; Cross et al., 1971; Larvrakas et al., 1976). For example, Cross et al. (1971) found an own-race bias in White individuals that was significantly correlated with the inter-racial experience. Note, however, that no such effect was observed in Black participants.

Other studies have failed to find any conclusive evidence supportive of the contact hypothesis (e.g., Luce, 1974; Malpass & Kravitz, 1969, Ng & Lindsay, 1994). For example, Ng and Lindsay (1994) had East Asian and White participants perform a face recognition task with own-and other-race faces, and correlated participants' contact scores with recognition sensitivity and bias measures. Ng and Lindsay found that both White and East Asian participants recognised own-race faces better than other-race faces. However, there was no relationship between inter-racial contact and increased recognition sensitivity. In a second study, they tested White and Asian participants who had recently emigrated to a majority other-race country. Ng and Lindsay reasoned that such individuals would have had greater opportunity for inter-racial contact; therefore, if contact supports other-race individuation, then participants should display increased other-race recognition. Again, there was still no compelling evidence to support a link between contact and increased other-race recognition.

In order to prevent potential socially desirable responding contaminating their results, other researchers have utilised cross-national samples, or samples that have had very limited exposure to other-race individuals (e.g., Chance, Goldstein, & McBride, 1982; Chiroro & Valentine, 1995; MacLin, Van Sickler, MacLin, & Li, 2004; Wright, Boyd, & Tredoux, 2001, 2003). If contact supports other-race recognition, then when there is little opportunity for interaction with a target racial group, recognition of that group should be reduced relative to own-race faces. For example Wright et al. (2003) measured the other-race effect in White students from the University of Bristol (a university in a predominantly White population, i.e., the United Kingdom) and White and Black students from the University of Cape Town a university in a predominantly Black population, i.e., South Africa). White students from either university exhibited better recognition of own-race faces, but Black students in Cape Town (who had very limited contact with White people) showed a strong own-race bias for Black faces. In this case, they observed a significant correlation between inter-racial contact and recognition for Black students.

In another African study, Chiroro and Valentine (1995) examined the other-race effect in high- and low-contact Black and White students in Zimbabwe. High contact was attributed on the basis that the participants attended a multi-racial college with greater opportunities for contact with the other race students. In contrast, low-contact students attended an institution where inter-racial contact was minimal or limited. Their results demonstrated that while the low-contact students exhibited clear racial biases in face recognition, the high-contact Black students recognised own-race and other-race faces equally well. High-contact White individuals, however, exhibited no reduction in their own-race bias. This appears to undermine the role of contact as a purely quantitative moderator of the other-race effect. However, the socio-political climate of Zimbabwe at the time meant that many communities were racially segregated, and so it remains possible that high-contact White and Black students differed in their degree of contact with the other racial group. Regardless, this would still suggest that mere contact in itself remains insufficient to overcome the other-race effect, a point I will return to in subsequent sections.

**3.2.4 The Multidimensional Face Space Model.** Although experienced-based explanations suggest a conceptual link between perceptual learning and improved ability to recognise other-race faces, no specific theoretical mechanism is proposed to account for the aforementioned improvement in recognition ability. Consistent with own-race experience corresponding to superior recognition of own-race faces, and relative inexperience corresponding with impoverished recognition of other-race faces, Valentine (1991, 2001; see also Valentine & Endo, 1992) proposed a *multidimensional face space* approach to face processing and the other-race effect. The multidimensional face space (MDFS) model assumes that faces are encoded as *dimensions* within "multidimensional face space", and that each individual's face-space is derived from their unique perceptual experience (Valentine, 1991, 2001).

Valentine (1991, 2001) proposed two differing versions of the MDFS model: (1) a *norm-based*, or *prototype-based* model, and (2) an *exemplar-based* model. In the norm-based model, faces are encoded as vectors within face-space, and in relation to their deviation from a single "norm" or prototype, which lies at the centre of face-space (Valentine & Bruce, 1986). In contrast, the exemplar-based model assumes there is no prototype face at all; instead, all faces are encoded as single points in multidimensional space. Both the norm-based and exemplar-based models assume that faces are unevenly distributed within face-space, but for different reasons. In the norm-based model, faces are heavily populated around the prototype, because these faces are more typical, and deviate less from the prototype face. In contrast, the outer regions of face space are less densely populated, as these faces tend to be highly distinctive from the prototype. The exemplar-based model predicts a similar arrangement, in that single points (i.e., encoded faces) form densely clustered areas, termed the central tendency, again because the faces are perceptually similar (Valentine, 1991).Unlike the prototype model, however, this central tendency has no active role in encoding faces, but merely indicates the point of maximum exemplar density (Valentine, 1991). Therefore, face recognition errors tend to occur when encoded faces are in close proximity to one another in face-space, as in the case of the exemplar-based model, or when encoded vectors are highly similar, as in the norm-based model. Valentine (1991, 2001) and Valentine and Endo (1992) advocate that any useful feature that aids discrimination between faces can be considered a "dimension"; however, Valentine is agnostic with regards to the precise dimensions that may support individuation in MDFS, although dimensions such as age and gender have been suggested by empirical data (e.g., Johnston, Kanazawa, Kato & Oda, 1997).

With regards to the other-race effect, although the norm and exemplar-based models vary conceptually, they still predict the same pattern of effect[1]. Valentine (1991, 2001) and Valentine and Endo (1992) argue that because we tend to encounter own-race faces more than other-race faces, and because face-space is a representation of all the faces we have encountered in our lifetime, the dimensions by which faces will be encoded will be the dimensions that are appropriate for discriminating between own-race but not other-race faces. The result is that other-race faces will densely cluster in a separate part of face space, because they are drawn from a different racial population. As other-race points are geographically closer together in face-space, other-race faces are more difficult to discriminate between and therefore recognise accurately (Valentine & Endo, 1992).

[1] There is a great deal of debate within the literature regarding weather a norm-based or an exemplar-based model more accurately conceptualises face processing. Valentine and Endo (1992) argued that an exemplar-based model provided the most parsimonious explanation of the other-race effect. However, evidence from the face adaptation effect suggests a norm-based explanation may be more appropriate (e.g., Leopold et al., 2001), and more recent data even suggests that there may be race-specific norms within face-space (e.g., Jaquet, Rhodes, & Hayward, 2008). Resolving these issues is beyond the scope of this thesis, but remains an important empirical question for future research.

The MDFS models framework is broadly supported by literature suggesting that we may use different features for discriminating between own-race and other-race faces (e.g., Bar-Haim, Saidel, & Yovel, 2009; Davies, Ellis, & Shepherd, 1977; Ellis, Deregowski, & Shepherd, 1975; Schyns, Bonnar, & Gosselin, 2002; Sergent, 1984). For example, there is evidence that White participants encode own-race faces using representations of the eyes in relation to the nose and mouth (e.g., Schyns, Bonnar, & Gosselin, 2002; Sergent, 1984), but other evidence suggests that information about the mouth and jaw line might be the most useful for discrimination of Black faces (e.g., Davies, Ellis, & Shepherd, 1977; Ellis, Deregowski, & Shepherd, 1975). Thus, the extraction of the kinds of information typically derived from own-race faces might not be the “right” kind of information to support the recognition of other-race faces and might actually be detrimental to recognition. Further, the MDFS model’s assertions have been substantiated with various experimental paradigms including: studies employing multidimensional scaling (e.g., Byatt & Rhodes, 2004; Johnston et al., 1997b; Lee, Byatt, & Rhodes, 2000; Papesh, & Goldinger, 2010); neural networks (Caldara & Abdi, 2006); behavioural-based classification studies (e.g., Johnston et al., 1997a); and studies which employ caricatures as stimuli (e.g., Byatt & Rhodes, 1998; Rhodes, Carey, Byatt, & Proffitt, 1998).

Despite the wealth of empirical evidence substantiating the MDFS approach, the model(s) are unable to provide an exhaustive account for all of the findings regarding the other-race effect. In particular, findings from studies employing ambiguous race faces have been problematic (e.g., Levin, & Banaji, 2006; MacLin & Malpass, 2001, 2003; Michel, Corneille, & Rossion, 2007; 2010; Pauker et al., 2009), indicating that although the poor recognition of other-race faces may reflect reduced perceptual experience, it also may also reflect (at least in some cases) the reduced motivation to individuate, or perhaps pay attention to them.

### 3.3 Attentional Accounts

Another prominent explanation of the other-race effect is that perceivers fail to pay attention to other-race individuals, termed "cognitive disregard" (Rodin, 1987). The cognitive disregard approach suggests that humans act like *cognitive misers* seeking cues for categorisation of individuals as outgroup members, enabling them to preserve cognitive resources for more elaborate or individuated processing of ingroup members. When this cue to outgroup status is activated, any further information is irrelevant and disregarded. In the other-race effect, racial cues would prompt disregard mechanisms (i.e., seeing them as "outgroup" or "Black" only), which means that potential individuating information would be disregarded, leading to poor other-race recognition (Malpass, 1990). Without an outgroup-specifying cue, attention is devoted to individuating information. This attentional account has two forms: the feature selection account (Levin, 1996, 2000); and the Ingroup/Outgroup Model (Sporer, 2001).

**3.3.1 Cognitive accounts: Feature selection.** The *feature selection* or *race categorisation* account of the other-race effect (Levin, 1996, 2000) argues that race-specifying information (for example, skin tone) is automatically encoded at the expense of visual information, therefore reducing the amount of individuating information encoded by perceiver and impairing recognition accuracy. Levin suggests that the other-race effect is not a failure to generalise perceptual familiarity; rather, it is a consequence of coding information that is optimal for categorisation (i.e., by group/race) rather than for individuation (see also Ge et al., 2009). More specifically, own-race faces are coded for individual identity, while other-race faces are coded for category-diagnostic information. This approach suggests that the other-race effect occurs due to inappropriate attention being directed to race at encoding (a mechanism similar to that of cognitive disregard; Rodin, 1987). When other-race faces are automatically coded by race, no further information processing takes place.

Support for feature selection hypothesis mainly comes from visual search tasks that require classification of faces by race, rather than recognition. For example, Levin (1996, 2000) used a visual search task where participants searched for a White or Black target, surrounded by varying numbers of other-race face distracters. Levin's logic was simple: If other-race faces are coded by race, search for Black faces (surrounded by White distracters) should be quicker than search for a White target (surrounded by Black distracters). Indeed, this was what Levin observed. Further, when participants were quick to locate other-race faces, they subsequently demonstrated poor other-race recognition. These results suggest that own- and other-race faces are coded in a feature-present/feature-absent manner. As other-race faces contain a feature diagnostic of racial difference (from oneself, or own- group), they are not subsequently processed further (Levin, 2000). Consistent with this, when own- and other-race faces are manipulated to appear more different from each other (i.e., producing caricatures that enhance race-specifying features), search asymmetries are facilitated. In contrast, when faces were manipulated to look more alike (i.e., producing prototypical faces, in which race is less salient between categories), search asymmetries are reduced (Levin & Angelone, 2001).

**3.3.2 Social accounts: The Ingroup/Outgroup Model.** Sporer's (2001) Ingroup/Outgroup Model of the other-race effect varies from Levin's feature selection account in that it sees face processing as essentially *social*. As such, motivation is assumed to play a pivotal role in forming ingroup (i.e., own-race) and outgroup (i.e., other-race) differences in face perception and recognition.

The model suggests that when a face is viewed, the race is initially processed. When the face is ingroup (i.e., own-race), "default" *configural* processing occurs, which is normally characteristic of own-race face processing. In brief, Sporer (2001) assumed that configural processing was *holistic* (i.e., that own-race faces are processed as a *gestalt* or "perceptual whole", e.g., Tanaka & Farah, 1993; Tanaka & Sengco, 1997; Young, Hellawell, & Hay, 1987), and relied on second-order relational, or configural coding (i.e., processing the discrete relations between facial features, e.g., Diamond & Carey, 1986; Rhodes, Brake, Taylor, & Tan, 1989)[2]. In contrast, when presented with outgroup (other-race) faces, cues to outgroup status initiate categorisation processes before typical face-processing strategies can begin. Ingroup categorisation therefore bypasses the categorisation phase when the presented target conforms to ingroup membership. Note that the dimensions along which ingroup and outgroup members vary are not salient and are therefore left unprocessed (consistent with Levin, 1996). Sporer (2001) proposed differing mechanisms may account for the poor recognition of other-race faces: (1) cues diagnostic to racial outgroup membership may serve as cues for cognitive disregard (Rodin, 1987), (2) outgroup categorisation may result in greater feature-based processing and undermining recognition of other-race faces (i.e., processing faces on a piecemeal feature by feature basis; e.g., Hancock & Rhodes, 2008; Michel et al., 2006; Rhodes et al., 1989; Rhodes, Ewing, & Evangelista, 2009; Sangrigoli & de Schonen, 2004; Tanaka et al., 2004), and (3) any further encoding that occurs may focus on information that differentiates outgroup membership from members of one's own group.

**3.3.3 Mixed evidence for attention-based accounts.** An indirect assumption of the feature-selection account and ingroup/outgroup model is that own-race face processing can somehow be "switched" to "look" like other-race processing and vice versa when given

[2] More information on configural, and holistic processing, their conceptual differences and how they relate to each other is detailed in Section 4, *How* the other-race effect operates, page 40.

appropriate instructions that negate the categorisation of other-race faces by race. Evidence in this area is mixed. Supportive evidence is provided by studies investigating recognition memory for ambiguous-race faces when categorised as own-race or other-race (Levin, & Banaji, 2006; MacLin & Malpass, 2001, 2003; Michel, Corneille, & Rossion, 2007; 2010; Pauker et al., 2009; but see Rhodes, Lie, Ewing, Evangelista, & Tanaka, 2010, for contrasting evidence). For example, MacLin and Malpass (2001, 2003) produced a set of racially ambiguous faces, and gave them different racial markers (either Black- or Hispanic-stereotypical hair). Interestingly, even when the faces were identical, differential racial makers changed how the face were categorised, as indicated by participants responding whether they believed the face to be White, Black Hispanic, Indian, or another race. These beliefs this affected memory, such that when a face was categorised as other-race, it was subsequently recognised poorly in comparison to when it was categorised as own-race.

More recently, Rhodes, Locke, Ewing, and Evangelista (2009) reasoned that if the other-race effect resulted from the *categorisation* of other-race faces, then inducing participants to categorise both own-race and other-race faces should eliminate the other-race effect. In one experiment, participants rated own-race and other-race study faces for race typicality or categorised faces by race. In another experiment, participants were instructed to individuate other-race faces (by warning participants about the other-race effect and instructing them to pay close attention to what differentiates one face from another). Rhodes et al. observed that rating racial typicality and categorising faces by race failed to reduce the other-race effect. Only individuation instructions helped reduce the appearance of other-race effect at recognition. The authors conclude that the other-race effect reflects the reduced perceptual experience people have with other-race individuals and the reduced motivation to process them, rather than resulting from the automatic categorisation of other-race faces by race-diagnostic cues (see also Rhodes, Lie, Ewing, Evangelista, & Tanaka, 2010).

### 3.4 Emerging Consensus: The Interaction of Experience and Motivation

As the foregoing review suggests, there is evidence both for and against perceptual experience and attentional accounts of the other-race effect. Attempting to determine which of the accounts best characterises the other-race effect thus seems impossible. More importantly, however, the debate overlooks the possibility that the accounts are not incompatible. Not knowing which other-race features are diagnostic and not processing other-race faces as fully as own-race faces, for example, might be mutually reinforcing.

**3.4.1 The Categorisation–Individuation Model.** Recently, Hugenberg, Young, Bernstein, and Sacco (2010) proposed the Categorisation–Individuation Model. This model integrates perceptual familiarity, feature selection, and ingroup/outgroup accounts of the other-race effect. Consistent with evidence that own-race faces tend to be processed more configurally than other-race faces (i.e., more in terms of spatial relationships between facial features; e.g., Hancock & Rhodes, 2008; Michel, et al., 2006; Michel, Corneille, & Rossion, 2007; Michel, Rossion, Han, Chung, & Caldara, 2006; Rhodes, Brake, Taylor, & Tan, 1989; Sangrigioli & de Schonen, 2004; Tanaka, Keifer, & Bukach, 2004), the core tenet of Categorisation–Individuation Model is that the other-race effect derives from the tendency to selectively attend to identity-diagnostic information (i.e., configural information) in own-race faces but to category-diagnostic information (e.g., skin tone) in other-race faces (See Hugenberg et al., 2010, p. 1170). Thus, the other-race effect has its roots in both perceptual experience and motivated processing.

The model proposes that selective attention to identity- versus category-diagnostic information in faces is determined by a number of factors. The first factor is the strength of *category activation* (i.e., with the presentation of a face, a social category is activated, such as race). Category activation is therefore privileged over individuation in face processing (Cloutier & Macrae, 2007; Cloutier, Mason, & Macrae, 2005; Quinn, Mason, & Macrae, 2010) and tends to be stronger for other-race than own-race faces (Levin, 1996, 2000; Stroessner, 1996). Situations that elicit strong own-race category activation should elicit stronger attention to category-diagnostic information in own-races faces. Indeed, Young, Hugenberg, Bernstein, and Sacco (2009) demonstrated that when own-race faces were seen in the context of other-race faces (specifically, when a block of own-race faces was preceded by a block of other-race faces), own-race recognition was significantly disrupted, presumably because the inter-racial context led own-race faces to be categorised rather than individuated.

The second factor in the Categorisation–Individual Model derives from the *signalling function* of categorisation. Social categories are assumed to signal to the perceiver the importance (or lack thereof) of target identity. All else being equal, ingroup membership informs the perceiver that the target's identity is important, whereas outgroup membership informs the perceiver that the target's identity is irrelevant (unless that outgroup membership is associated with some form of threat; Ackerman et al., 2006; Becker et al., 2010; Shriver & Hugenberg, 2010). In the context of the other-race effect, this means that participants should be more *motivated* to direct attention to identity-diagnostic information in own-race than other-race faces.

Race, however, is only one cue to shared or non-shared category membership and thus to the importance of individuation. According to the Categorisation–Individuation Model, any ingroup- or outgroup-specifying information (e.g., category label, context) can signal identity importance and determine the motivation to individuate. For own-race faces, outgroup-specifying information can undermine motivation, whereas for other-race faces, ingroup-specifying information can enhance motivation. Evidence for the motivation-undermining effects of outgroup-specifying information on *own-race* processing comes from investigations in which racial ingroup/outgroup status is crossed with non-racial ingroup status (typically in the form of university affiliation). Hugenberg and Corneille (2009), for example, demonstrated that outgroup (versus ingroup) categorisation reduces configural processing of own-race faces, and Bernstein, Young, and Hugenberg (2007) demonstrated that outgroup (versus ingroup) categorisation undermines recognition of own-race faces.

Shriver, Young, Hugenberg, Bernstein, and Lanter (2008) replicated Bernstein et al.'s recognition effects with both university affiliation and social class as indicators of ingroup/outgroup status. Importantly, Shriver et al. investigated recognition of both own-race and other-race faces, and failed to find evidence that ingroup-specifying information enhanced other-race recognition. This finding highlights the importance of the final factor included in the Categorisation–Individuation Model: perceivers' *prior individuation experience* in discriminating faces within a racial category, which interacts with the motivation to process faces in terms of identity- versus category-specifying information. Because of de facto segregation, most perceivers have significantly more individuation experience with own-race than other-race faces, and have developed processing strategies that lead to the efficient extraction of identity-specifying information from own-race faces. Because own-race and other-race faces often differ in terms of the dimensions that are useful from discriminating identity (e.g., Hills & Lewis, 2006; Shepherd & Deregowski, 1981), the expertise that perceivers develop with own-race faces transfers imperfectly to the processing of other-race faces.

In terms of the Shriver et al. results, the Categorisation–Individuation Model assumes that the effectiveness of individuation motives is constrained by individuation experience. The motivation to individuate is assumed by the model to elicit a processing shift even for other-race faces, but without experience in discriminating faces *according to the appropriate dimensions*, successful individuation is likely to be limited. Thus, in the Shriver et al. studies, participants may have attempted to shift their attention to identity-diagnostic information for ingroup-categorised other-race faces but, due to a lack of perceptual experience, were unsuccessful.

In addition to the effectiveness of individuation being constrained by individuation experience, individuation experience is constrained by individuation motives. That is, the benefits of individuation experience are only fully exploited when perceivers are motivated to individuate faces. When motivation decreases, as when own-race faces are assigned to an outgroup category, individuation decreases despite experience (Bernstein et al., 2007; Shriver et al., 2008). Hugenberg et al. argue that the lack of individuation of outgroup-categorised own-race faces stems from the fact that expertise with individuation does not preclude expertise with categorisation. That is, when the motivation to individuate own-race faces is undermined by outgroup-specifying information, perceivers are readily able to shift their attention to category-specifying information, leading own-race recognition to drop to the recognition levels for other-race faces (but see Hayward, Rhodes, & Schwaninger, 2008, for evidence that recognition for own-race faces is not always disrupted by the use of non-identity-diagnostic (i.e., non-configural) processing).

***3.4.1.1 Both own- and other-race face processing are susceptible to ingroup/outgroup categorisation effects.*** Although the Categorisation–Individuation Model usefully integrates several different factors affecting face processing, allowing it to account for a broad set of data, it is unable to account easily for several other findings in the other-race effect literature. First, despite Shriver et al.’s (2008) null findings regarding the impact of categorisation on the processing of other-race faces, other research suggests that other-race processing is malleable. McKone, Brewer, McPherson, Rhodes, and Hayward (2007), for example, familiarised White participants with a small number of unambiguous other-race faces and found that participants subsequently exhibited greater configural processing for familiar than for unfamiliar other-race faces, with inversion costs for familiar other-race faces equal to those found for own-race faces (note that the face inversion effect is an indirect way of measuring configural processing, e.g., Michel et al., 2006; Tanaka & Gordon, 2011). As the training provided to participants was minimal, these results suggest that perceivers can switch relatively easily between configural and featural processing for other-race faces.

Moreover, Hehman, Mania, and Gaertner (2010) used a modified face-recognition paradigm in which they were able to control the relative salience of racial and non-racial ingroup/outgroup status. They found that when target faces were grouped by race, participants recognised more own-race than other-race faces, regardless of university affiliation; when target faces were grouped by university affiliation, however, participants recognised more own-university than other-university faces, regardless of race. Thus, other-race recognition can be influenced by non-racial ingroup/outgroup status. Moreover, Hehman et al.'s findings— two non-interacting main effects: one for target university, and one for target race —raise important questions as to whether perceptual experience and motivation really interact to determine processing (see also Hehman, Stanley, Gaertner, & Simons, 2011).

These deviations from Hugenberg and colleagues' (Bernstein et al., 2007; Shriver et al., 2008) findings can be explained within the Categorisation–Individuation Model through its assumption that individuation motives and experience are mutually constraining. Nonetheless, they raise important questions of *when* and *how* ingroup/outgroup categorisation influences face processing. For example, are there factors at encoding that influence the signalling function of categorisation? I agree that the fundamental tenets of the Categorisation-Individuation model are valid: Perceivers have greater individuation experience for own-race than other-race faces and greater individuation motivation for ingroup than outgroup faces and these two factors constrain one another. What is missing in the current instantiation of the Categorisation–Individuation Model, however, is a clear account of *when* and *how* individuation experience constrains individuation motivation and vice versa. It is not straightforwardly the case that the motivation to individuate trumps extensive individuation experience for own-race faces, or that a lack of individuation experience can trump the motivation to individuate other-race faces.

This broad limitation is evident in three respects. First, the Categorisation–Individuation Model is relatively vague with respect to the factors that might heighten or diminish the signalling function of ingroup-/outgroup-specifying information. This is not a limitation per se, but it does leave room for theoretical refinement. Second, the model links ingroup categorisation with the motivation to individuate, and individuation with configural processing, but presents little direct evidence for a link between ingroup categorisation and configural processing—or indeed, that poor outgroup recognition is linked to feature-based or category-based representation. For example, recognition memory studies supporting the Categorisation–Individuation Model have failed to employ any manipulation of processing (e.g., Bernstein, et al., 2007, Hugenberg et al., 2007; Shriver et al., 2008; Shriver & Hugenberg, 2010; Young et al., 2009; Young, Bernstein, & Hugenberg, 2010; Young & Hugenberg, 2011). One exception is the recent evidence from Hugenberg and Corneille (2009) that for own-race faces, ingroup categorisation prompts more holistic processing than does outgroup categorisation. Nonetheless, this is only one demonstration, and to date there is no evidence of whether the same link would emerge with other-race faces, which tend to be processed less configurally (e.g., Michel et al., 2006; Rhodes, Brake, Taylor, & Tan, 1989; Hancock & Rhodes, 2008). Finally, the model also assumes that only ingroup-/outgroup-specifying information is relevant in determining perceivers' motivation to individuate faces—or, at least, ingroup-/outgroup-specifying information is the only factor that is discussed in the model's presentation. It is possible, however, that other factors (e.g., active goals, task requirements) can prompt more or less configural processing, and thus more or less of the "types" of processing that support individuation.

# 4 Theoretical Approaches: *How* the Other-Race Effect Operates

## 4.1 Configural, Holistic and Feature-Based Processing

There is a great deal of agreement within the literature that faces are processed configurally, more so than any other type of visual object (e.g., Carey, 1992; Farah, Wilson, Drain, & Tanaka, 1998; Leder & Bruce, 2000; Leder, Candrian, Huber, & Bruce, 2001; McKone, Martini, & Nakayama, 2001; Rossion & Gauthier, 2002; Tanaka & Sengco, 1997), an assertion that has been corroborated by a recent meta-analytic review (Bruyer, 2011). However, there is far less consensus about what "configural" processing actually means (Farah et al., 1998; Goldstein & Chance, 1980; Rossion, 2008, 2009; Leder & Bruce, 2000; for reviews, see Bruyer, 2011; Maurer, Le Grand, & Mondloch, 2002; McKone & Robbins, 2011; Searcy & Bartlett, 1996; Tanaka & Gordon, 2011), partly because the term has been used interchangeably to refer to conceptually different types of processing. For example, Maurer et al. (2002) suggest there are three different types of configural processing: (1) sensitivity to *first-order relations* (or perceiving the common configuration of all faces; i.e., two eyes above a mouth; e.g., Diamond & Carey, 1986); (2) sensitivity to *second-order relations* (i.e., the processing of discrete spatial dimensions between independent features in the face; e.g., Diamond & Carey, 1986; Rhodes, 1988); and (3) *holistic processing* (i.e., processing the face as a perceptual "whole" or gestalt without decomposing the target into specific features; e.g., Donnelly & Davidoff, 1999; Farah, Tanaka, & Drain, 1995; Tanaka & Farah, 1993; 2003; Tanaka & Sengco, 1997). I am agnostic concerning the "type" of configural processing that is implicated within this thesis, or indeed, whether it is "configural" or "holistic". However, I adopt the same convention as Hugenberg et al. (2010) in their formulation of the Categorisation–Individuation Model, and discuss holistic processing as a subset of configural processing (see Hugenberg et al., 2010; Maurer et al., 2002).

Feature-based processing (sometimes termed "*piecemeal*" or "*component*" processing) is a qualitatively different process from configural processing, whereby faces are processed in terms of their independent component parts (e.g., nose, eyes, chin; e.g., Diamond & Carey, 1986; Leder & Bruce, 2000; Rhodes et al., 1989; Sergent, 1984; Tanaka & Farah, 1993). There has been some debate about what constitutes a "component" in feature-based processing. Bartlett, Searcy, and Abdi (2003) suggest that it is implicit within the literature that features are those components of the face that can be independently described from each other (i.e., their description is not interdependent on other components), are localised in their spatial extent, and mark discontinuities within the surface of the face.

**4.2 Configural, Feature-Based Processing and the Other-Race Effect**

A perennial theme within the other-race effect literature is that perceivers are more aware of and sensitive to the facial features and configurations that differentiate own-race faces than other-race faces (Byatt & Rhodes, 2004; Chiroro & Valentine, 1995; Corenblum & Meissner, 2006; Furl et al., 2002; Hills & Lewis, 2004; Valentine, 2001; Walker & Hewstone, 2006a). Many researchers also advocate a "special" form of processing for own-race faces that is qualitatively different from how we process other-race faces (Brigham & Malpass, 1985; Goldstein & Chance, 1985; Murray, Rhodes, & Shuchinsky, 2003).

In fact, there is evidence that own-race and other-race faces tend to be processed in qualitatively different ways. Specifically, there is evidence that own-race faces tend to be processed more configurally (i.e., in terms of the spatial relationships between facial features), whereas other-race faces tend to be processed in a more feature-based manner (e.g., Greenberg & MacGregor, 2010; Hancock & Rhodes, 2008; Michel, Caldara, & Rossion, 2006; Michel et al., 2006; Rhodes et al., 1989; Rhodes, Ewing, Hayward, Maurer, Mondloch, & Tanaka, 2009; Sangrigoli & de Schonen, 2004; Stahl, Weise, Holger, & Schweinberger, 2008; Tanaka, Kiefer, & Bukach, 2004). For example, Tanaka, Kiefer, and Bukach (2004) had participants perform a delayed perceptual matching task, where participants saw a target face followed by test stimuli that consisted of isolated face parts (eyes, noses or mouths) or face parts embedded within a whole face. The results demonstrated that White participants demonstrated a whole-face recognition advantage (i.e., better recognition when parts were presented within the context of a face, rather than in isolation), but only for own-race faces. Asian participants, however, demonstrated a whole-face advantage irrespective of race. Tanaka et al. interpreted this pattern as reflecting participants' overall inter-racial experience, in that their Asian participants had more experience with Whites than vice versa. This suggests that the other-race effect arises from holistic processing of own-race faces (i.e., processing the face as a whole gestalt, or the features of the face as interdependent parts) and featural processing of other-race faces (i.e., processing the features of the face in isolation).

Michel et al. (2006) used the *face-composite illusion* to examine the holistic processing of own-race and other-race faces. In the face-composite paradigm, participants judge whether the top halves of two faces are identical or different; these faces are connected with bottom halves that are also either identical or different. A reliable outcome is that participants perceive identical top halves of faces as different (or are slower to recognise them as identical) when they are joined with the bottom halves of two different faces (Young et al., 1987). The reasoning is that participants form a "gestalt" or holistic representation of the entire face, such that the top and bottom halves are "fused" into a coherent whole rather than being represented as independent features—interfering with participants' ability to detect that the top halves of the face depict the same identity. In Michel et al.'s study, White and Asian participants were asked to make same/different judgements to own-race and other-race faces. Two faces (denoted as "study" and "test" faces) were presented sequentially. The target faces were aligned or misaligned composites in which the top halves depicted the same individual or two different individuals. Both Asian and White participants processed own-race faces more holistically, as evidenced by responses to a half-face target being more disrupted when the faces were aligned relative to when they were misaligned. Michel et al. interpreted their results as demonstrating that holistic/configural processing increased with perceptual familiarity.

Other researchers have also found evidence for the configural processing of own- but not other-race faces using the *face inversion effect*. Face inversion (i.e., rotating faces by 180°) has been assumed to be more detrimental to configural than feature-based processing (Diamond & Carey, 1986; Thompson, 1980; Yin, 1969; but see McKone & Yovel, 2009; Rhodes et al., 2006; Tanaka & Farah, 1991), as presumably inverting faces makes it harder to extract the discrete spatial differences between features within the face that aid differentiation. For example, Rhodes, Brake, Taylor, and Tan (1989) examined recognition of own- and other-race faces using face inversion as a marker of configural processing. Their logic was that if poorer extraction of configural information underlies the other-race effect, then inversion effects should be smaller for other-race relative to own-race faces. Indeed, this is the general pattern of effect that was observed. This suggests that configural processing is necessary for subsequent recognition and differentiation (see also Buckhout & Regan, 1988; Gajewski, Schlegel, Stoerig, 2008; Hancock, & Rhodes, 2008, McKone et al., 2007; Murray et al., 2003; Rhodes et al., 1989; Vizioli, Foreman, Rousselet, & Caldara, 2010).

More recently, Hancock and Rhodes (2008) investigated the extent to which the quantity and quality of inter-racial contact modulated the face inversion in effect in recognition memory in Chinese and White participants. The results demonstrated that White and Chinese participants recognised faces of their own race more than the other-race faces, and inversion affected own-race recognition more than other-race recognition. Interestingly, however, both of these factors (face-inversion effects and recognition) were modulated by inter-racial contact. Increased contact reduced the other-race effect, and increased inversion decrements for other-race faces. In summary, this suggests that configural processing is used to a greater extent for own-race faces, but that its use is also modulated by experience with other-race individuals.

### 4.3 Factors that Inhibit or Facilitate the Configural Processing of Faces

Thus far, and generally in line with the Categorisation–Individuation Model, I have presented two factors rooted in perceptual familiarity that tend to recruit greater levels of configural-based processing: own-race faces (e.g., Greenberg & MacGregor, 2010; Hancock & Rhodes, 2008; Michel, Caldara, & Rossion, 2006; Michel et al., 2006; Rhodes et al., 1989; Rhodes et al., 2009; Sangrigoli & de Schonen, 2004; Stahl, Weise et al., 2008; Tanaka, Kiefer, & Bukach, 2004), and upright faces (as compared to inverted faces; e..g., Diamond & Carey, 1986; Thompson, 1980; Yin, 1969; but see McKone & Yovel, 2009; Rhodes et al., 2006). There are several other factors at encoding that can facilitate configural processing, irrespective of one's perceptual experience. I start by discussing the processes of individuation versus categorisation and their relation to processing, which is generally accounted for by the Categorisation–Individuation Model (Hugenberg et al., 2010). I then outline other encoding factors that serve to either enhance or restrict configural processing, which are yet to be accounted for by the Categorisation–Individuation Model.

**4.3.1 Individuation versus categorisation.** According to the social cognition literature, there are two opposing ways of processing faces at encoding: categorisation and individuation (e.g., Fiske & Neuberg, 1990; Brewer, 1988). Categorisation can be defined as the classification of exemplars (i.e., target faces) into groups based upon shared dimensions, for example, classifying faces at the level of race (e.g., Macrae & Bodenhausen, 2000). In contrast, individuation is the discrimination between exemplars from within a given category (Kunda & Spencer, 2003; Fiske & Neuberg, 1990; Brewer, 1988; Macrae & Bodenhausen, 2000), or recognising the identity of a target.

The face tends to provide many competing cues that can either aid the process of categorisation, or individuation. Individuation (or being able to distinguish between exemplars of a particular group), according to the face perception literature at least, requires analysis of relational or configural-based processing (e.g., Gauthier & Tarr, 1997; Sergent, 1984; Rhodes et al., 1989). In contrast to individuation, categorisation of an exemplar is less dependent upon processing configural information. Instead, categorisation can be achieved simply by analysing single facial features (i.e., feature-based processing; Brown & Perrett, 1993; Diamond & Carey, 1986; Rhodes, 1988; Levin, 1996, 2000). For example, categorisation on the basis of race can be accomplished with relative ease by analysis of facial features that may conform to racial group membership, such as afrocentric features (e.g., Blair, Chapleau & Judd, 2005; Blaire, Judd & Chapleau, 2004; Blair, Judd, & Fallman, 2004; Blair, Judd, Sadler, & Jenkins, 2002) or racially stereotypic hairstyles (e.g., MacLin & Malpass, 2001, 2003; Macrae & Martin, 2006; Martin & Macrae, 2007). Indeed, evidence has supported a conceptual link between configural processing and individuation, and categorisation and feature-based processing. For example, Mason and Macrae (2004) used a divided visual field paradigm, where participants had to perform categorical judgements (i.e., "Are these faces the same sex?") and individuated judgements (i.e., "Are these faces the same person?") with pairs of faces that were either presented to the left or right hemisphere (Experiment 1). Given that there is evidence suggestive of a right hemisphere advantage in face recognition and sensitivity to configural information (e.g., Leehey, Carey, Diamond, & Cahn, 1978; Rhodes, 1985, 1993; Yin, 1969), and a left hemisphere advantage in processing the local aspects of visual stimuli (Fink, Halligan, Marshall, Frith, Frackowiak, & Dolan, 1996; Robertson & Lamb, 1991; Kosslyn, 1987), Mason and Macrae reasoned that if individuation is served by configural processing, then participants should be more accurate at making individuation judgements when the faces were presented to the right hemisphere than when presented to the left hemisphere. Indeed, this is exactly what Mason and Macrae observed. Furthermore, in another follow-up experiment, individuation judgements were observed to modulate activity in the right fusiform gyrus, and right inferior gyrus, whereas categorisation judgements modulated activity in the left inferior frontal and left superior temporal gyri (Mason & Macrae, 2004, Experiment 3).

In a more recent set of studies, Michel, Corneille, and Rossion (2007, 2009) asked White participants to make same/different judgements to sequentially presented pairs of White, Asian, and racially ambiguous (i.e., White–Asian morphed) faces, making use again of the composite-face illusion. When racially ambiguous faces were cued as own-race rather than other-race, participants processed the faces more holistically, as evidenced by responses to a half-face target being more disrupted when the faces were aligned relative to when they were misaligned. These results suggest that the motivation to individuate own-race faces, results in stronger configural processing than when faces are categorised as racial outgroup members—at least when the targets are racially ambiguous.

There is also evidence that categorisation can affect the structural encoding of own-race faces. Hugenberg and Corneille (2009), again using the face-composite manipulation, asked White participants to make same/different judgements to sequentially presented pairs of own-race faces categorised as ingroup or outgroup members on the basis of university affiliation. Participants showed greater configural processing when faces were categorised as ingroup members than when they were categorised as outgroup members. These results suggest that outgroup categorisation is sufficient to debilitate the strong "default" configural processing normally observed for own-race faces.

In summary, there is clear evidence for a link between individuation relying largely on configural processing (Mason & Macrae, 2004; Michel et al., 2007, 2010) and categorisation relying either less on configural processing or more on feature-based processing (Mason & Macrae, 2004; Michel et al., 2007, 2010; Hugenberg & Corneille, 2009). This is broadly in line with the assertions of the Categorisation–Individuation Model (i.e., the respective roles of configural vs. featural processing in individuated and category directed processing). It is therefore surprising that no direct tests of ingroup/outgroup categorisation on the processing of both own-race and other-race face processing have been put forward in support of the Categorisation–Individuation Model at the time of writing this thesis, apart from that of Hugenberg and Corneille (2009). Even so, Hugenberg and Corneille (2009) only examined the processing White faces, by White participants. Therefore, the only information for categorisation or individuation was the university ingroup/outgroup priming procedure they employed. A true understanding of the effects of categorisation and individuation in the other-race effect can only be achieved when there is a second racial group of stimuli and therefore alternatives for the categorisation or individuation of targets.

**4.3.2 Encoding operations bias face processing.** There is evidence that the way stimuli are encoded can depend on the goals of the task. According to Levels of Processing Theory (Craik & Lockhart, 1972; Craik & Tulving, 1975), recognition memory is dependent upon encoding mode: "Deep" elaborated processing, relative to "shallow" perceptual processing, results in better subsequent memory. Classically, Levels of Processing theory suggests that deep encoding requires the extraction of semantic information and is based on abstract processing, whereas shallow encoding is more superficial and based on perceptual processing (Craik & Lockhart, 1972). In support with this account, several studies have demonstrated that judging faces for likeability or making other trait judgements on faces results in better recognition than categorising faces by gender or making superficial judgements about, for example, the size of a particular facial feature (e.g., Berman, & Cutler, 1998; Bower & Karlin, 1974; Biber, Butters, Rosen, Gerstman, & Mattis, 1981; Courtois & Mueller, 1979; Clifford & Prior, 1980; McKelvie, 1985, 1991, 1996; Petterson & Baddeley, 1977; Sporer, 1991; Wells & Turtile, 1988, Winograd, 1981; for reviews, see Coin & Tiberghien, 1997; Winograd, 1978). There are also several studies suggesting that configural processing is more likely to be engaged under deep than shallow encoding conditions (Marzi & Viggiano, 2010; McKelvie, 1985, 1995, 1996).

Given that face encoding may change as a function of the depth of processing, then it is plausible to expect that effects of social categorisation and perceptual experience may vary with the encoding context, too. The Categorisation–Individuation Model does support the idea that the other-race effect is broadly accounted for by encoding phenomena (see Young, Bernstein, & Hugenberg, 2010). It is therefore surprising that in its current form it has not considered the role of depth of processing at encoding in modulating differences in the processing of, and memory for, ingroup-/outgroup-categorised own-race and other-race targets.

# 5 Thesis Overview

## 5.1 Aims and General Hypotheses

In light of the reviewed literature, this thesis begins with the assumption, central to the Categorisation–Individuation Model, that the other-race effect derives from both limited perceptual experience with and weaker motivation to individuate other-race relative to own-race faces. Nonetheless, I take the position that the Categorisation–Individuation Model is limited in that it assumes (at least implicitly) that only ingroup-/outgroup-specifying information is relevant in determining perceivers' motivation to individuate faces. The overarching aim is thus to investigate additional cues that possess signalling function during own- and other-race face processing, thereby clarify the motivational mechanisms underlying the other-race effect and extending the Categorisation–Individuation Model. This overarching aim includes three more specific aims.

**5.1.1 Understanding the role of context.** In Chapter 2, I report two experiments that aim to test whether and how context modulates the impact of ingroup-/outgroup-specifying cues. In line with the Categorisation–Individuation Model, I hypothesise that the context in which own- and other-race faces are encountered can determine the salience of racial category membership, with implications for how (and how much) non-racial ingroup/outgroup status influences the configural processing of own- and other-race face perception. As of yet, there have been no direct tests of configural processing under such conditions, at least using both own- and other-race faces as stimuli.

**5.1.2 Exploring the role of encoding goals and ongoing processing demands.** In Chapter 3, I report four experiments that aim to test whether the relative reliance on configural versus featural information that is assumed to characterise identity-directed versus category-directed processing can be modulated by cues other than those that specify ingroup/outgroup status. I hypothesise that encoding goals can lead perceivers toward more or less configural processing regardless of target ingroup/outgroup status, but with implications for the influence of ingroup/outgroup status.

**5.1.3 Investigating the time course of racial and non-racial ingroup/outgroup status effects.** In Chapter 4, I report one experiment with the aim of examining the neural correlates of ingroup/outgroup categorisation on own- and other-race face processing. The Categorisation-Individuation does not give any formal definition of what facial characteristics aid individuation versus categorisation. Investigating the electrophysiological correlates of feature-based and configural processing in ingroup/outgroup categorisation will provide insights into what actually underpins the observed behavioural effects. I hypothesise that both racial and non-racial ingroup/outgroup status have the potential to influence different early stages of face perception.

## 5.2 General Methodological Approach

In this thesis, unfamiliar own- and other-race faces were labelled as ingroup or outgroup members. Specifically, the effects of social categorisation were investigated by labelling own- and other-race faces as being either from participants' home institution, the University of Birmingham, or a rival institution, the University of Nottingham. Faces were presented in either upright or inverted orientation (Chapters 2–4), or manipulated to form face composites (Chapter 5) to allow for the measurement of configural and holistic processing, respectively. In Chapter 2, I investigated the effects of ingroup/outgroup categorisation on the *perceptual discrimination* of own- and other-race faces; inversion was used to assess configural encoding. I also considered the signalling function of the context, by using either randomised presentation of own- and other-race faces (creating an inter-racial context; Experiment 1) or by blocking the presentation of the faces by race (creating an intra-racial context; Experiment 2). In Chapter 3, I investigated the effects of ingroup/outgroup categorisation on the *recognition* of own- and other-race faces. Here, I also considered the signalling function of the encoding task by investigating own- and other-race face recognition when participants encoded faces for later recognition (Experiments 3, 5) or had a more globally orientated encoding goal (i.e., rating trait likeability; Experiments 4, 6); the effects on processing were also explored with the addition of face inversion (Experiments 5–6). In Chapter 4 (Experiment 7), I tested the contribution of ingroup/outgroup categorisation to own- and other-race face processing using event-related potentials, specifically focusing on structural encoding (i.e., the N170 component). Finally, Chapter 5 acknowledges the potential limitations of using face-inversion effects as markers of configural processing; Experiment 8 investigated the effects of ingroup/outgroup categorisation on perceptual discrimination in the face-composite paradigm, an alternatives means of isolating configural processing. In Chapter 6, I discuss the implications of these studies for the face processing and social cognitive literature, and re-evaluate the Categorisation–Individuation Model.

# CHAPTER 2

# PERCEPTUAL DISCRIMINATION OF OWN- AND OTHER-RACE FACES AS A FUNCTION OF INGROUP/OUTGROUP CATEGORISATION AND INTER-GROUP/INTRA-GROUP CONTEXT[3]

*The current chapter examined the impact of ingroup/outgroup categorisation on the encoding of own-race and other-race faces presented in inter-racial and intra-racial contexts (Experiments 1 and 2, respectively); face inversion provided an index of configural processing. White participants performed a same/different matching task on pairs of upright and inverted faces that were either own-race or other-race, and labelled as being from their own university or another university. In Experiment 1, the own- and other-race faces were intermixed, creating an inter-group context. The results revealed that for other-race faces, participants demonstrated greater configural processing following own- than other-university labelling. Own-race faces showed strong configural coding irrespective of the university labelling. In Experiment 2, faces were blocked by race, creating an intra-group context for each block. Participants demonstrated greater configural processing of own- than other-university faces, but now for both own- and other-race faces. These experiments demonstrate that other-race face processing is sensitive to non-racial ingroup/outgroup status regardless of racial context, but that the sensitivity of own-race face processing to the same cues depends on the racial context in which targets are encountered.*

[3] Experiments 1 and 2 are reported in Cassidy, K. D., Quinn, K. A., & Humphreys (2011). The influence of ingroup/outgroup categorization on same- and other-race face processing: The moderating role of inter- versus intra-racial context. *Journal of Experimental Social Psychology, 47,* 811–817.

# 1 Introduction

The Categorisation–Individuation Model (Hugenberg et al., 2010) provides a broad theoretical framework within which we can understand the effects of ingroup/outgroup categorisation on own- and other-race face processing. The model proposes that the other-race effect derives from a tendency to attend selectively to individuating information in own-race faces and category-diagnostic information in other-race faces. According to the model, this difference in attentional allocation arises because ingroup status signals that identity is important, whereas outgroup status signals that it is not—leading to the further proposition that non-racial ingroup/outgroup status can also prompt differential attention to identity- versus category-diagnostic cues. The aim of the research reported in the current chapter was to examine the impact of racial versus non-racial category salience in shaping own-race and other-race face processing.

## 1.1 Ingroup/Outgroup Categorisation and Own- versus Other-Race Face Processing

The Categorisation–Individuation Model suggests that any cues to ingroup/outgroup status can signal identity importance and the motivation to individuate. These cues need not be racial: For own-race faces, outgroup categorisation can undermine the motivation to process beyond a category level, whereas for other-race faces, ingroup categorisation can enhance the motivation to process other-race faces.

Indeed, as reviewed in Chapter 1 (Section 3.4.1), several studies have provided support for the hypothesis that ingroup/outgroup categorisation influences own-race face processing. Hugenberg and Corneille (2009), for example, demonstrated that outgroup (versus ingroup) categorisation reduces configural processing of own-race faces; Bernstein et al. (2007) demonstrated that outgroup (versus ingroup) categorisation undermines recognition of own-race faces; and Young et al. (2009) demonstrated that when own-race faces were seen in the context of other-race faces (specifically, when a block of own-race faces was preceded by a block of other-race faces), own-race recognition was significantly disrupted, presumably because the inter-racial context led own-race faces to be categorised rather than individuated

It is important to note that these demonstrations come from experiments examining White participants' processing and recognition for ingroup- versus outgroup-categorised White (i.e., own-race) faces. Evidence for ingroup/outgroup categorisation effects for other-race face processing, however, is less clear. Shriver et al. (2008), for example, replicated Bernstein et al.'s (2007) effects for own-race targets, but failed to find an effect for other-race targets. More recently, however, Young and Hugenberg (2011) demonstrated that warning participants about the other-race effect and asking them to try to avoid it (Experiment 1) or including angry faces among the stimuli (Experiment 2)—two procedures designed to heighten the motivation to individuate—led participants to respond to the ingroup/outgroup categorisation manipulation similarly for own- and other-race targets, that is, by showing improved recognition for ingroup-categorised faces (regardless of race). Importantly, however, the effect of motivation in the first experiment was modulated by inter-racial experience, such that only those participants with relatively extensive experience showed improved recognition for ingroup-categorised other-race faces.

### 1.2 Racial Salience and Ingroup/Outgroup Categorisation

The above evidence indicates that categorisation of own-race faces as outgroup members impairs configural processing and recognition of own-race faces, and that the categorisation of other-race faces as ingroup members sometimes improves recognition of other-race faces. Thus, it appears that own-race face processing responds in a more stable manner to ingroup/outgroup categorisation than does other-race face processing. Aspects of their respective designs, however, may explain some of the differences. In particular, the investigations of other-race face processing have included both own- and other-race faces in their designs, whereas the investigations of own-race face processing have included only own-races faces.

According to the Categorisation–Individuation model, any ingroup- or outgroup-specifying information (e.g., category label, context) can signal identity importance and determine the motivation to individuate, and this should be equally true for own- and other-race targets (notwithstanding the role of experience). One possibility is that in the foregoing research, the design differences inadvertently made race more or less salient. In some circumstances, racial ingroup/outgroup membership may provide the primary dimension for categorisation, with implications for processing and memory. In other circumstances, however, racial ingroup/outgroup membership may represent only one among multiple possible dimensions for categorisation, and may not be perceived as the primary or most useful dimension; when other dimensions are used, differences in configural processing and recognition might emerge.

**1.3 Overview**

In the current research, I sought to investigate the role of ingroup/outgroup categorisation on the perceptual encoding of own-race and other-race faces, with an eye to testing and clarifying the Categorisation–Individuation Model. I examined how different categorisation contexts (inter- and intra-racial) affected face processing for both own-race and other-race faces. I report two experiments. In Experiment 1, I aimed to investigate the effects of ingroup/outgroup categorisation on the perceptual encoding of own- and other-race faces in an inter-racial context. In Experiment 2, I investigated whether the same pattern of effects would emerge when faces were presented in an intra-racial context (i.e., when presentation of faces was blocked by race). In both experiments, I used a perceptual matching task, and presented the faces either upright or inverted by 180°, using inversion costs (i.e., impaired processing for inverted relative to upright faces) as a marker of configural processing.

## 2 Experiment 1

In Experiment 1, I examined the effects of ingroup/outgroup university affiliation on face processing when own-race faces were presented along with other-race faces—that is, in an inter-racial context that provided both race and university affiliation as dimensions for ingroup/outgroup categorisation. Following past research (Hugenberg & Corneille, 2009), I expected that perceivers would engage in greater configural processing (i.e., demonstrate larger inversion costs) for own-university than other-university faces. However, I also expected that the inter-racial context would serve to keep race salient as a categorisation alternative, with potential implications for the strength of university-based categorisation effects. In particular, given perceivers' likely fluency in the configural processing of own-race races and the possibility that the salience of the own-/other-race distinction would lead participants to view White as "ingroup" regardless of university affiliation, I expected that race salience would mitigate the influence of the newly-assigned group membership (i.e., university affiliation) for the processing of own-race faces. As a consequence, I expected that evidence for greater configural processing of own-university than other-university faces would emerge more strongly—or perhaps even only—for other-race faces (following Michel et al., 2007, 2009).

### 2.1 Method

**2.1.1 Participants and design.** Thirty-three students from the University of Birmingham completed the study for course credit; all had normal or corrected-to-normal vision. The data for one participant were removed from the analysis because of an error rate in excess of 20%, leaving 32 participants (31 female; $M_{age}$ = 20.3 years). The experiment was based on a 2 (trial type: same, different) × 2 (target race: own-race, other-race) × 2 (target university: own-university, other-university) × 2 (target orientation: upright, inverted) within-participants design.

**2.1.2 Materials.** The materials included face stimuli and university primes. The face stimuli were graphic files depicting 80 Black and 80 White faces, taken from previous research (Shriver, Young, Hugenberg, Bernstein, & Lanter, 2008) as well as from the CAL/PAL face database (Minear & Park, 2004) and the Stanford face database (Eberhardt, Davies, Purdie-Vaughns, & Johnson, 2006). All faces were adult men in a forward pose with neutral expressions. The images were standardised in Adobe Photoshop CS2 to be greyscale and sized 236 pixels vertically. An inverted version of each face was also created by rotating each image 180°. This resulted in a total of 320 experimental stimuli. The university primes were graphic files depicting the University of Birmingham (own-university prime) and University of Nottingham (other-university prime) names (in their respective corporate fonts) and official crests.

The face stimuli were grouped into same-race, same-orientation pairs, with an effort to match paired stimuli along a variety of dimensions (e.g., luminance, contrast, head/hair shape)[4]. The pairs were divided into sets such that each face appeared as an ingroup member for some participants but an outgroup member for others, and on a "same" trial for some but a "different" trial for others. Each face appeared four times per set (twice upright and twice inverted). Each stimulus set included 384 experimental trials, presented in random order.

**2.1.3 Procedure.** After providing informed consent, participants completed a short task designed to enhance their ingroup identification/self-categorisation as students at the

[4] This procedure meant that for "different" trials, any given face was always paired with the same other face. Although random pairing would have been optimal, this procedure was necessary to minimise participants' ability to use non-identity specifying cues such as hair shape, or skin tone to make "different" judgements (because such cues obviously could not be used to make "same" judgements).

University of Birmingham (adapted from Haslam, Oakes, Reynolds, & Turner, 1999). Specifically, participants received a survey, allegedly from Student Services, with the following instructions:

> As a member of the University of Birmingham, you've joined one of the most exciting academic communities in the country. For over a hundred years, the university has contributed to the advancement of knowledge and its application. The University of Birmingham has around 26,000 students from the UK and all over the world, and it's a great place to study. As part of our continuing effort to understand what motivates our students and makes our community unique, we would be grateful if you could take a few minutes and think about the University of Birmingham's identity, and the ways in which you are like your fellow University of Birmingham students. When you have done this, please write down your thoughts.

These instructions were followed by five blank lines, numbered 1 to 5. (Participants were not instructed to fill all five lines.)

Participants then completed the target face perception task; all instructions and stimuli were presented via a personal computer running MediaLab and DirectRT research software (Empirisoft Corporation, 2006). Participants learned that during the task, they would see faces of students from either the University of Birmingham or the University of Nottingham[5]. They learned further than on each trial of the task, they would see two faces and that their task was to indicate as quickly and accurately as possible, by means of a key press, whether the faces depicted the same individual or two different individuals. Trials were initiated with the presentation of a fixation cross for 500 ms, followed by the university prime that appeared

[5] I chose the University of Nottingham as the outgroup university because of its similarity to the University of Birmingham (e.g., geographic region, status, student demographics) and familiarity to the University of Birmingham students. It is thus a relevant comparison for the University of Birmingham students, without invoking status issues.

centred at the top of the screen for 1500 ms. Two faces then appeared below the prime, flanking the central fixation cross, and were displayed until participants produced a response. The intertrial interval was 1000 ms. Responses and their latencies were recorded by the computer program. Figure 1 depicts examples of stimuli used during the task.

On task completion, participants completed an inter-racial contact questionnaire (Voci & Hewstone, 2003; see Appendix A). Participants responded to four randomly ordered questions about the quantity of contact with Black individuals (e.g., "How frequently do you have contact with Black people?") along 5-point scales anchored by *never* and *very frequently* and to three randomly ordered questions about quality of contact with Black individuals (e.g., "When you meet Black students, in general do you find the contact pleasant?") along 5-point scales anchored by *not at all* and *very*.

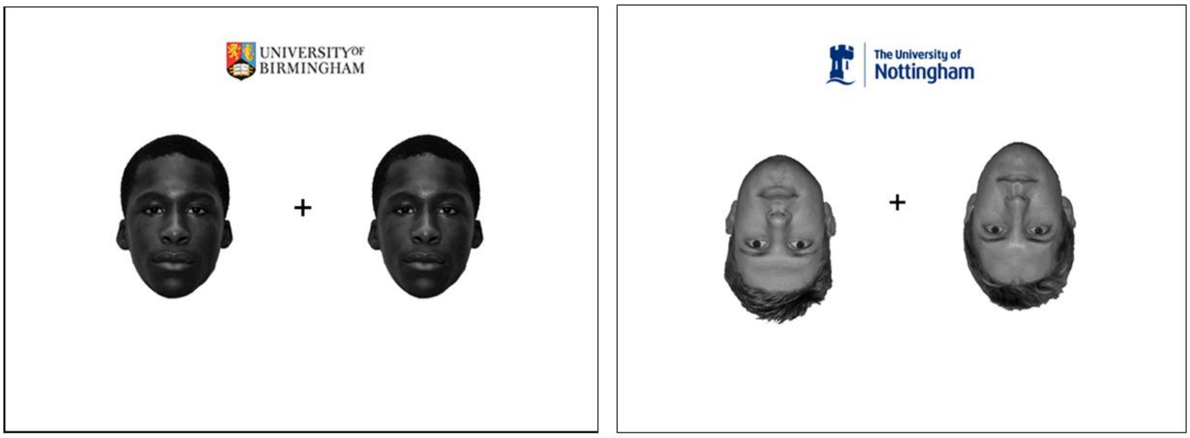


***Figure 1.*** **Example stimuli used in Experiments 1–2. Left panel: upright other-race, own-university "same" trial; right panel: inverted own-race, other-university "different" trial.**

## 2.2 Results

**2.2.1 Perceptual discrimination.** Mean discrimination latencies served as the dependent measure of interest[6]. Due to the presence of outlying responses in the data set, response times over 2.5 standard deviations from the participant's mean were excluded (6.09% of the data) along with trials where errors were committed (2.69% of the data). The data were submitted to a 2 (trial type: same, different) × 2 (target race: own-race, other-race) × 2 (target university: own-university, other-university) × 2 (target orientation: upright, inverted) repeated-measures analysis of variance (ANOVA). Condition means and the ANOVA summary table are presented in Appendix B.

The analysis revealed a significant main effect of target orientation, $F(1, 31) = 48.23$, $p < .001$, $\eta_p^2 = .60$, demonstrating that participants were slower to discriminate inverted than upright targets (*M*s = 992 and 913 ms, respectively). There was also a number of significant interactions: Trial Type × Target University, $F(1, 31) = 35.77$, $p < .001$, $\eta_p^2 = .54$; Trial Type × Target Race × Target University, $F(1, 31) = 7.65$, $p = .009$, $\eta_p^2 = .19$; and the predicted Target Race × Target University × Target Orientation interaction, $F(1, 31) = 7.57$, $p = .01$, $\eta_p^2 = .20$. The Trial Type × Target University and Trial Type × Target Race × Target University interactions failed to moderate or interact with the predicted pattern, and so were not analysed further. However, the Trial Type × Target Race × Target University means are presented in Table 1 for the reader's interest[7].

The predicted Target Race × Target University × Target Orientation interaction was analysed further by conducting separate Target University × Target Orientation ANOVAs for

[6] Error rates were also analysed. Error rates were generally low (2.69%), and mirrored the reaction time data (i.e. there was no evidence for a speed-accuracy trade off) . Condition means and the ANOVA summary table are presented in Appendix C for the reader's interest. .

[7] In general, the pattern suggested that participants were faster to respond "same" to own-university than other-university targets and faster to respond "different" to other-university than own-university targets. This pattern was more pronounced for own-race than other-race targets.

each target race (see Figure 2). For own-race faces, there was only a significant main effect of target orientation, $F(1, 31) = 24.87$, $p < .001$, $\eta_p^2 = .45$. Participants responded more quickly to upright targets than to inverted targets (*M*s = 909 and 989 ms, respectively); university categorisation did not affect performance, $F(1, 31) = 0.52$, $p = .48$, $\eta_p^2 = .016$.

For other-race targets, the analysis revealed a significant main effect of target orientation, $F(1,31) = 55.29$, $p < .001$, $\eta_p^2 = .64$, which was subsumed within a significant Target University × Target Orientation interaction, $F(1, 31) = 11.84$, $p = .002$, $\eta_p^2 = .28$. Participants responded more quickly to upright versus inverted other-race targets for both own-university targets, $t(31) = 7.18$, $p < .001$, and other-university targets, $t(31) = 4.39$, $p < .001$; however, inversion was significantly more disruptive for own-university than other-university targets, $t(31) = 3.04$, $p = .005$.

**Table 1**
***Mean discrimination latencies (ms) as a function of trial type, target race, and target university, Experiment 1***

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| "Same" trials | | |
| Own race (White) | 925 (35.29) | 962 (43.48) |
| Other race (Black) | 924 (34.57) | 950 (36.28) |
| "Different" trials | | |
| Own race (White) | 999 (46.20) | 934 (52.68) |
| Other race (Black) | 971 (37.57) | 955 (41.11) |

*Note*. Numbers in parentheses represent standard error.

**2.2.2 Inter-racial contact.** Separate scores for quantity and quality of inter-racial contact were calculated by averaging across the items separately for each subscale of the contact questionnaire (Cronbach's α = .91 and .67, respectively).

If experience increases the likelihood of processing other-race faces configurally (e.g., Rossion & Michel, 2011), then participants reporting higher (versus lower) levels of inter-racial contact should show stronger inversion costs in their processing of other-race faces.

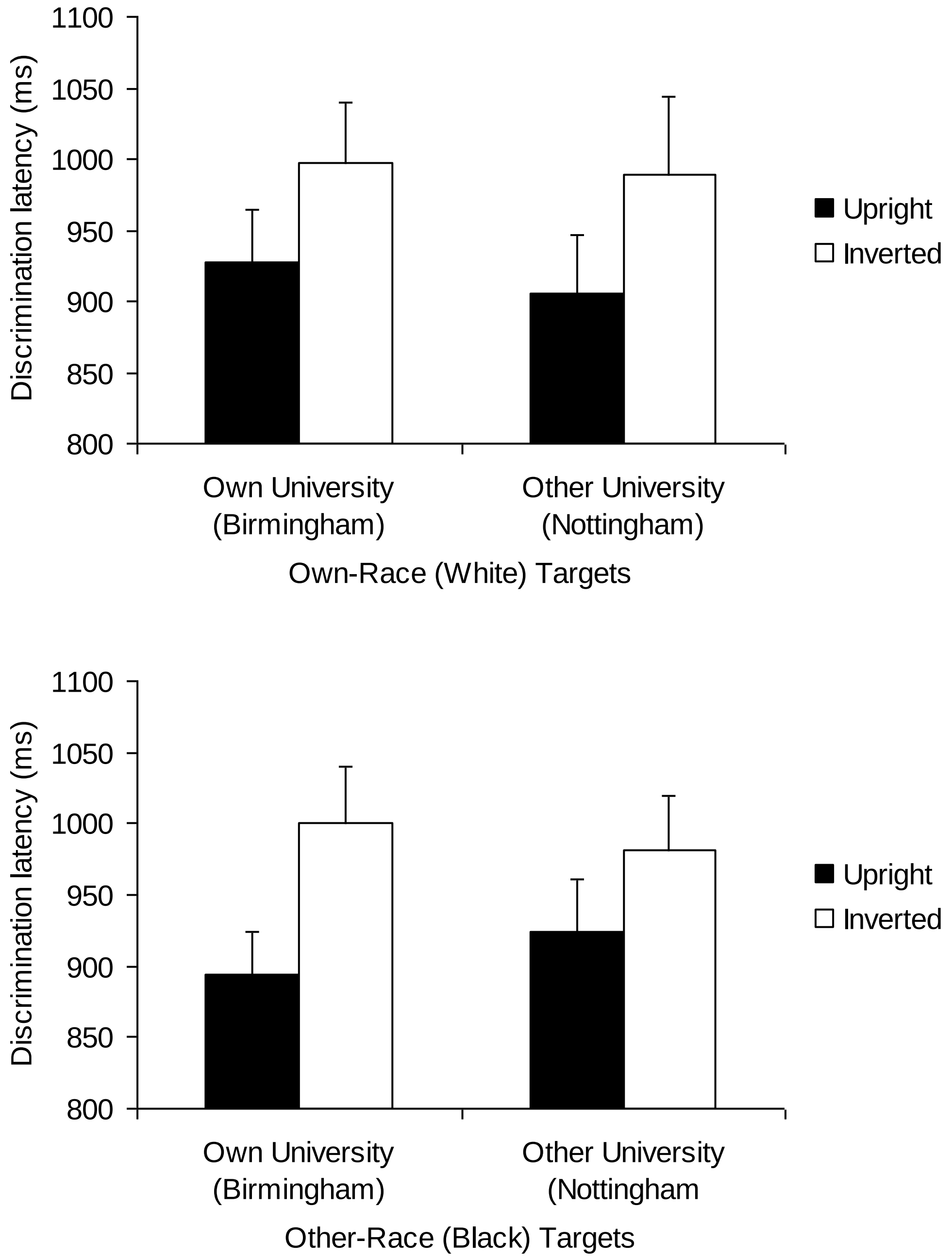


***Figure 2.*** **Mean discrimination latencies (ms) as a function of target race, university, and orientation, Experiment 1.** *Note.* Error bars denote standard error.

Inversion costs for other-race faces, as a function of university affiliation, were submitted to a correlational analysis (Spearman's rho) with participants' self-reported quality and quantity of contact. The analysis revealed no significant correlations between either the quantity (all *p*s > .71) or quality of contact (all *p*s > .07) and inversion costs for either own- or other-university other-race faces (see Appendix D). The results of Experiment 1 are therefore not explained by simple differences in inter-racial experience.

### 2.3 Discussion

The current study examined how non-race-based ingroup/outgroup categorisation influenced the perceptual encoding of own-race and other-race faces presented in an inter-racial context. In addition to the typically observed face-inversion effect (i.e., faster RTs for upright than inverted faces), the results demonstrated that, for other-race faces, inversion was more disruptive to the discrimination of own-university than other-university faces. For own-race faces, however, there were no effects of ingroup/outgroup categorisation based on university affiliation, and inversion was equally disruptive to the discrimination of own-university and other-university faces.

I argue that this pattern emerged because the inter-racial context kept race salient as a dimension for categorisation. For own-race faces, race salience would serve to encourage the typically observed differences in the processing of own- and other-race faces, that is, more configural processing of own-race faces. For own-race faces, the equivalence in processing own-university and other-university faces suggests that this "default" processing, once activated, is sufficiently fluent to mitigate against sensitivity to other bases for ingroup/outgroup categorisation. For other-race faces, however, lack of expertise means that configural processing is not the default but can be employed when ingroup membership is stressed, as here by university affiliation.

# 3 Experiment 2

Experiment 2 examined the effects of ingroup/outgroup status on face processing in an intra-racial context—that is, when own-race and other-race faces were presented in separate blocks, making university affiliation the most salient ingroup/outgroup categorisation within each block. In past research (Hugenberg & Corneille, 2009), university categorisation yielded stronger configural processing for own-university than other-university faces. That research, however, examined the processing of own-race faces only. I extended this research to other-race face processing. In this context, I expected that participants would engage in greater configural processing of ingroup (own-university) than outgroup (other-university) faces irrespective of target race. Hugenberg and Corneille's work suggests that when race salience is minimised, the configural processes normally associated with own-race faces can be disrupted by outgroup categorisation along another dimension. If outgroup categorisation can disrupt the configural processing of own-race faces, then it should be equally able to disrupt the processing of other-race faces, with which perceivers often lack experience.

## 3.1 Method

**3.1.1 Participants and design**. Forty-four students from the University of Birmingham completed the study for course credit; all had normal or corrected-to-normal vision. The data for one participant were removed from the analysis because of an error rate in excess of 20%, leaving 43 participants (41 female; $M_{age}$ = 20.7 years). The experiment was based on a 2 (trial type: same, different) × 2 (target race: own-race, other-race) × 2 (target university: own-university, other-university) × 2 (target orientation: upright, inverted) × 2 (block order: own-race-first, other-race-first) mixed design with block order as a between-participants factor.

**3.1.2 Materials**. The materials were as in Experiment 1.

**3.1.3 Procedure.** The procedure was as in Experiment 1, with one exception. Rather than completing the same/different task in one fully randomised block, participants completed the task in two blocks, one comprised only of Black faces and the other comprised only of White faces. Block order was randomised across participants.

### 3.2 Results

**3.2.1 Discrimination latency.** Mean discrimination latencies served as the dependent measure of interest. Due to the presence of outlying responses in the data set, response times over 2.5 standard deviations from the mean were excluded (1.99% of the data) along with trials where errors were committed (5.48% of the data). The data were submitted to a 2 (trial type: same, different) × 2 (target race: own-race, other-race) × 2 (target university: own-university, other-university) × 2 (target orientation: upright, inverted) × 2 (block order: own-race-first, other-race-first) mixed-model ANOVA with block order as a between-participants factor[8]. Condition means and the ANOVA summary table are presented in Appendix E.

The analysis revealed a significant main effect of target orientation, $F(1, 42) = 52.20$, $p < .001$, $\eta_p^2 = .55$, demonstrating that participants were faster to discriminate upright than inverted targets (*M*s = 795 and 842 ms, respectively). There was also a main effect of trial type, $F(1, 42) = 6.87$, $p = .012$, $\eta_p^2 = .14$, such that participants were faster to respond "same" than "different" (*M*s = 805 and 831 ms, respectively).

The analysis also yielded a number of significant interactions: Trial Type × Target Race, $F(1, 42) = 4.29$, $p = .045$, $\eta_p^2 = .093$; Trial Type × Target University, $F(1, 42) = 11.08$, $p = .002$, $\eta_p^2 = .209$; Trial Type × Target Orientation, $F(1, 42) = 5.85$, $p = .020$, $\eta_p^2 = .12$; Target Race × Block Order, $F(1, 42) = 7.87$, $p = .008$, $\eta_p^2 = .16$; and Trial Type × Target Race

[8] I also analysed error rates. Again, error rates were generally low (5.48%), and generally mirrored the pattern of reaction times (i.e., there was no evidence of a speed-accuracy trade off). Condition means and the ANOVA summary tables are presented in Appendix F for the reader's interest.

× Target University × Block Order, $F(1, 42) = 5.49$, $p = .024$, $\eta_p^2 = .12$. These interactions failed to moderate or interact with the predicted pattern, and so were not analysed further. Means for the highest-order interactions (Trial Type × Target Orientation; Trial Type × Target Race × Target University × Block Order) are presented in Tables 2 and 3, respectively, for the reader's interest[9].

**Table 2**
***Mean discrimination latencies (ms) as a function of trial type and target orientation, Experiment 2***

| | Upright faces | Inverted faces |
|---|---|---|
| "Same" trials | 788 (19.78) | 823 (24.21) |
| "Different" trials | 802 (17.45) | 860 (20.61) |

*Note*. Numbers in parentheses represent standard error.

Importantly, the analysis also yielded the predicted Target University × Target Orientation interaction, $F(1, 42) = 12.17$, $p = .001$, $\eta_p^2 = .23$ (see Figure 3). This interaction was analyzed further by conducting paired *t*-tests, which demonstrated that, regardless of target race, participants were faster to respond to upright than inverted faces for both own-university targets, $t(43) = 7.57$, $p = .001$, and other-university targets, $t(43) = 5.82$, $p = .001$. Moreover, as with other-race targets in Experiment 1, the inversion cost was greater for own-university than other-university targets, $t(43) = 3.51$, $p = .003$. Unlike in Experiment 1, however, this pattern was not moderated by target race (Target Race × Target University × Target Orientation, $F(1, 42) = 0.053$, $p = .82$, $\eta_p^2 = .001$).

**3.2.2 Inter-racial contact.** Separate scores for quantity and quality of inter-racial contact were calculated by averaging across the items separately for each subscale of the contact questionnaire (Cronbach's alphas = .87 and .67, respectively). Correlational analysis

[9] In general, the Trial Type × Target Orientation effect suggested that inversion costs were greater for "different" trials. The Trial Type × Target Race × Target Orientation × Block Order interaction was less clear-cut than the Trial Type × Target Orientation interaction found in Experiment 1. Again, the interaction provided general support for a pattern whereby participants were faster to respond "same" to own-university, than other-university targets, and "different" to other-university than same-university targets.

(Spearman's rho) revealed no significant correlations between either the quantity (all *p*s >.90), or quality of contact (all *p*s > .42) and inversion costs for either own- or other-university other-race faces (see Appendix G). The aforementioned latency results are therefore not explained by simple differences in racial experience.

**Table 3**
***Mean discrimination latencies (ms) as a function of trial type, target race, target university, and block order, Experiment 2***

| | Own-race block first | | Other-race block first | |
|---|---|---|---|---|
| | Own university (Birmingham) | Other university (Nottingham) | Own university (Birmingham) | Other university (Nottingham) |
| "Same" trials | | | | |
| Own race (White) | 817 (30.62) | 840 (32.46) | 761 (30.62) | 778 (32.46) |
| Other race (Black) | 806 (33.13) | 816 (36.59) | 795 (33.13) | 828 (36.59) |
| "Different" trials | | | | |
| Own race (White) | 895 (28.24) | 863 (29.15) | 796 (28.24) | 795 (29.16) |
| Other race (Black) | 818 (27.53) | 823 (29.69) | 829 (27.53) | 832 (29.69) |

*Note*. Numbers in parentheses represent standard error.

**3.3 Discussion**

The current study examined how non-racial bases for ingroup/outgroup categorisation influence the perceptual encoding of own-race and other-race faces presented in an intra-racial context. I once again found typical face-inversion effects, and replicated the pattern of Experiment 1 in which inversion was more disruptive for the discrimination of other-race faces when those faces were categorised as own-university versus other-university. However, in contrast to Experiment 1, ingroup/outgroup categorisation also influenced own-race face processing; inversion was more disruptive to the discrimination of own-race faces when categorised as own-university versus other-university. The aforementioned pattern of results for own-race faces is broadly in line with Hugenberg et al. (2009). When race salience was minimised, participants' processing was guided by cues to university status, which would be most salient given the intra-racial context. For own-race faces, this meant that cues to outgroup membership reduced the motivation to process these faces in a configural manner Hugenberg et al. (2010).

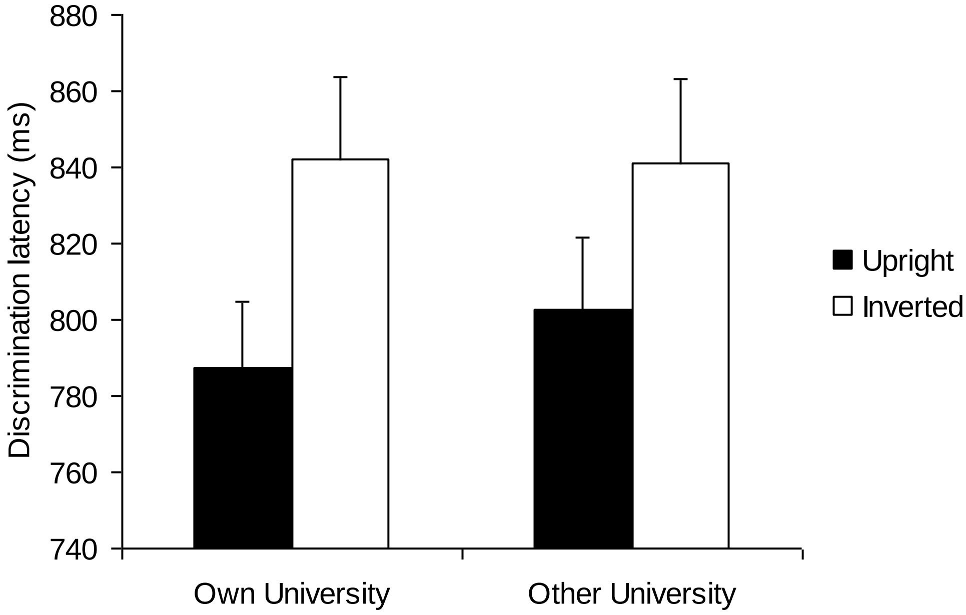


***Figure 3.*** **Mean discrimination latencies (ms) as a function of target university and orientation, Experiment 2.** *Note.* Error bars represent standard error.

## 4 General Discussion

The results of these two experiments demonstrate that other-race face processing is sensitive to non-racial ingroup/outgroup status regardless of racial context, but that the sensitivity of own-race face processing to the same cues depends on the racial context in which targets are encountered. For other-race faces, non-racial ingroup/outgroup categorisation influenced the way in which the faces were encoded, a novel result within the social categorisation literature. Inversion was more disruptive to the processing of other-race faces when those faces were categorised as ingroup rather than outgroup members on the basis of university affiliation, suggesting that non-racial ingroup categorisation induced stronger configural encoding. Moreover, this pattern held true regardless of whether the faces were presented in inter-racial (i.e., intermixed presentation) or intra-racial (i.e., blocked presentation) contexts.

For own-race faces, non-racial ingroup/outgroup categorisation influenced the way in which the faces were encoded, but only in the intra-racial context. In this context, inversion was more disruptive to the processing of own-university than other-university faces. In the inter-racial context, however, inversion was equally disruptive to own-university and other-university faces. I suggest that when Black and White faces were intermixed, race became salient as a dimension for categorisation and the familiarity and visibility of racial ingroup/outgroup status trumped university-based ingroup/outgroup status, such that all faces were perceived in terms of race. As a result, all own-race faces were perceived as ingroup members, and configural processing was adopted as the default. Only when racial groupings were weighted less strongly—when the faces were blocked by race—did participants perceive own-race other-university faces as outgroup members and override the configural processing default.

Stated differently, context can determine whether own-race faces are perceived as ingroup versus outgroup members, and inter-racial contexts promote ingroup categorisation. This interpretation is supported by follow-up contrasts that explored the effect of context, in which I combined the own-race data from Experiments 1 and 2. As I would expect, own-university faces were perceived as ingroup members regardless of the context in which they were presented; that is, inversion costs (and presumably configural processing) were equivalent for own-university faces presented in intra-racial and inter-racial contexts (*M*s = 53 vs. 69 ms, respectively; $t(74) = 1.001$, $p = .32$). Other-university faces, however, were perceived as outgroup members to a greater extent when race was less salient; that is, inversion costs were smaller (indicating less configural processing) for other-university faces presented in an intra-racial rather than inter-racial context (*M*s = 38 vs. 84 ms, respectively; $t(74) = 2.29$, $p = .025$).

The findings for the intra-racial context are consistent with previous research, which has focused on the effects of social categorisation when own-race faces are encoded. Hugenberg and Corneille (2009), for example, presented own-race faces and provided evidence for greater configural processing of ingroup- than outgroup-categorised targets. These data indicate that social categorisation can influence the extent to which own-race faces are processed configurally when the faces are presented in a mono-racial context. My evidence, however, also demonstrates that this pattern does not hold for own-race faces when they appear in an inter-racial context, where non-racial ingroup-outgroup categorisation exerts negligible influence. I suggest this reflects the increased salience of race when own-race and other-race faces are presented together. In this context, there might be automatic categorisation of own-race faces as ingroup members (on the basis of race) that triggers configural encoding and is insensitive to non-visible ingroup/outgroup status. For other-race faces, however, the motivation afforded by another form of ingroup categorisation may sufficient to offset categorisation by visual cues such as race, leading to greater configural processing for ingroup than for outgroup members.

The findings also extend recent work by Hehman et al. (2010), who examined the effects of race and university categorisation on recognition memory. Hehman et al. used a modified face-recognition paradigm where Black and White faces were spatially grouped at encoding by race or university affiliation to equate the salience of the two dimensions. Their results demonstrated that when target faces were grouped by race, participants recognised more own-race than other-race faces, irrespective of university affiliation. When target faces were grouped by university, however, participants recognised more ingroup than outgroup faces, irrespective of race. The authors explained their results in terms of the Common Ingroup Identity Model (Gaertner & Dovidio, 2000), whereby a shared category dimension can offset the influence of a non-shared dimension—at least as long as the dimensions are equally salient. My research adds to that of Hehman et al. by providing evidence of what happens when the processing context sets two potential categorisation dimensions in competition (and where one is more visibly salient): When own- and other-race faces are encountered in a mixed context, racial and non-racial forms of categorisation interact to guide encoding.

### 4.1 Conclusion

The current research demonstrated that the relative impact of non-racial ingroup/outgroup categorisation on the encoding of own-race and other-race faces depends critically on context. Other-race face processing is sensitive to non-racial ingroup/outgroup status regardless of racial context, but the sensitivity of own-race face processing to the same cues depends on the racial context in which targets are encountered; for own-race faces, non-racial ingroup/outgroup status exerts influence primarily in intra-racial contexts. I suggest that pre-existing (race) and newly generated group (university affiliation) categorisations can interact to modulate face encoding, and that processing of other-race faces is more sensitive to the availability of alternative ingroup/outgroup dimensions than is the processing of own-race faces.

# CHAPTER 3:

# RECOGNITION OF OWN- AND OTHER-RACE FACES AS A FUNCTION OF INGROUP/OUTGROUP CATEGORISATION: THE MODERATING ROLE OF ENCODING GOALS [10]

*The current chapter examined the impact of ingroup/outgroup categorisation and encoding goals on memory for own-race and other-race faces. White participants studied faces for later recognition (memory-directed encoding; Experiments 3, 5) or evaluated faces for likeability (trait-directed encoding; Experiments 4, 6) and then completed a recognition test; face inversion provided an index of configural processing (Experiment 5–6). The results revealed that when participants explicitly encoded faces for later recognition, outgroup categorisation impaired own-race recognition, but ingroup/outgroup categorisation had no effect for other-race faces (Experiments 3, 5.).Under trait-directed encoding, however, ingroup/outgroup categorisation had no effect for own-race faces, but outgroup categorisation impaired other-race recognition (Experiment 4). The face-inversion manipulation revealed important processing differences as a function of encoding goal: When participants encoded faces for later recognition, inversion effects even for own-race faces were negligible, suggesting that memory-directed encoding goals may limit configural processing (Experiment 5); without this goal, only outgroup-categorised other-race faces failed to elicit inversion effects (Experiment 6). These experiments demonstrate that encoding goals interact with racial and non-racial ingroup/outgroup status to determine processes and outcomes in face recognition.*

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[10] Experiments 3-6 are reported in Cassidy, K. D., Humphreys, G. W., and Quinn, K.A.. (in preparation). *The influence of ingroup/outgroup categorization on own-and other-race face processing: The moderating role of encoding goals.*

# 1 Introduction

The Categorisation–Individuation Model (Hugenberg et al., 2010) proposes that the other-race effect derives from the tendency to attend to identity-diagnostic information in own-race faces but to category-diagnostic information in other-race faces, and that the effect has its roots in both perceptual experience and motivated processing, which constrain one another. The model assumes that the effectiveness of individuation motives is constrained by individuation experience, and that the effectiveness of individuation experience is constrained by individuation motives. In essence, the model assumes that ingroup/outgroup categorisation can determine the *quantity* or *depth* of processing, with ingroup categorisation providing greater motivation to individuate than outgroup categorisation; the extent to which greater motivation translates into better recognition, however, is constrained by experience, with own-race faces being easier to individuate than other-races faces. The current chapter aimed to extend the Categorisation–Individuation Model to include not only the quantity or depth of processing, but also the *quality* or *nature* of processing, as determined by the encoding goal of the participant. .

## 1.1 Motivation and Recognition of Own- and Other-Race Faces

According to the Categorisation–Individuation Model, any ingroup- or outgroup-specifying information (e.g., category label, context) can signal identity importance and determine the motivation to individuate. For own-race faces, outgroup-specifying information can undermine motivation and subsequent recognition, whereas for other-race faces, ingroup-specifying information can enhance motivation and subsequent recognition. In support of this reasoning, Bernstein et al. (2007) demonstrated that outgroup categorisation undermined recognition of own-race faces. Contradicting this reasoning, however, Shriver et al. (2008) found no evidence, that ingroup categorisation improved recognition of other-race faces. They suggested that the increased motivation to attend to identity-diagnostic information in ingroup other-race faces was constrained by a lack of individuation experience with this category of faces. Thus, although participants may have attempted to shift their attention to identity-diagnostic information in ingroup other-race faces, their lack of experience with these faces made them unsuccessful.

Despite Shriver et al.'s failure to find evidence that motivation influences other-race recognition, other evidence does suggest that memory for other-race faces is relatively malleable. McKone et al. (2007), for example, familiarised White participants with a small number of unambiguous other-race faces and found that participants subsequently exhibited greater configural processing for familiar than for unfamiliar other-race faces, with inversion costs for familiar other-race faces equal to those found for own-race faces. More recently, Hehman et al. (2010) used a modified face-recognition paradigm in which they were able to control the relative salience of racial and non-racial ingroup/outgroup status. They found that when target faces were grouped by race, participants recognized more own-race than other-race faces, regardless of university affiliation. When target faces were grouped by university affiliation, however, participants recognized more own-university than other-university faces, regardless of race (see also Hehman, Stanley, Gaertner, & Simons, 2011). Finally, my own research has also demonstrated ingroup/outgroup categorisation effects on the processing of other-race faces, dependent on contextual cues (Cassidy et al., 2011; see Chapter 2). Thus, other-race face processing can be influenced by non-racial ingroup/outgroup status and cues that highlight individuating versus category-specifying information.

Although these data broadly support the assumption of the Categorisation–Individuation Model that motivation and experience interact to guide processing, two other aspects of Chapter 2's findings are noteworthy. First, I did *not* find evidence that ingroup/outgroup categorisation influenced the configural processing of own-race faces, suggesting that extensive experience can sometimes override motivation. Second, I *did* find evidence that ingroup/outgroup categorisation influenced the configural processing of other-race faces, at least in intra-racial contexts, suggesting that motivation can sometimes make up for a lack of experience. These findings raise important questions of *when* and *how* ingroup/outgroup categorisation influences face processing. For example, are effects of social context and processing experience modulated by the goal of encoding – whether faces are coded intentionally for later memory or whether memory coding is incidental to the main task? This was investigated here in this chapter.

**1.2 Effects of Encoding Goals**

The mixed evidence for the influence of ingroup/outgroup categorisation on the processing of own-race and other-race faces raises important questions of when and how ingroup/outgroup categorisation influences face recognition. I suggest that one important factor is the nature of the conditions at encoding. Specifically, encoding goals that prompt configural processing may be more compatible with individuated face representation, where as goals that prompt feature-based processing may be more compatible with category-level representation (Levin, 1996, 2000).

There is evidence that the way stimuli are encoded can depend on the goals of the task. According to Levels of Processing Theory (Craik & Lockhart, 1972; Craik & Tulving, 1975), recognition memory is dependent upon encoding mode: “Deep” elaborated processing, relative to “shallow” perceptual processing, results in better subsequent memory. Classically, Levels of Processing theory suggests that deep encoding requires the extraction of semantic information and is based on abstract processing, whereas shallow encoding is more superficial and based on perceptual processing (Craik & Lockhart, 1972). In support with this account, several studies have demonstrated that judging faces for likeability or making other trait judgements on faces results in better recognition than categorising faces by gender or making superficial judgements about, for example, the size of a particular facial feature (e.g., Berman, & Cutler, 1998; Bower & Karlin, 1974; Biber et al., 1981; Courtois & Mueller, 1979; Clifford & Prior, 1980; McKelvie, 1985, 1991, 1996; Petterson & Baddeley, 1977; Sporer, 1991; Wells & Turtile, 1988, Winograd, 1981; for reviews, see Coin & Tiberghien, 1997; Winograd, 1978). Of particular relevance to the current research there are also several studies suggesting that configural processing is more likely to be engaged under deep than shallow encoding conditions (Marzi & Viggiano, 2010; McKelvie, 1985, 1995, 1996). For example, McKelvie (1985) found that the recognition advantage of judging faces on the basis of likeability (deep encoding) versus gender (shallow encoding) was eliminated when faces were inverted. As inversion is assumed to be a way of disrupting configural processing (cf. Yin, 1969), poor recognition performance on inverted-face trials was taken as evidence that deeper encoding recruited more configural processing. Similarly, McKelvie (1991) demonstrated that inversion disrupted recognition accuracy following trait judgements, but not following judgements of distinctive facial features (see also McKelvie, 1995; although see Valentine & Bruce, 1986, for alternative evidence).

### 1.3 Overview

Given that face encoding may change as a function of the depth of processing, I expect that effects of social context and perceptual expertise may vary with the encoding context, too. Here I examined this idea in the context of varying whether faces were encoded intentionally for later memory or incidentally, when another task was required and then a surprise memory test was given. Young et al. (2009) and Shriver et al. (2008) examined intentional memory encoding and found that outgroup categorisation disrupted own-race face recognition but ingroup categorisation conveyed no advantage for other-race faces. These data suggest that intentional memory coding is sensitive to category-level processes, disruptive for own-race faces but the default for other-race faces. I replicated these data in Experiments 3 and 5. Incidental memory was tested in Experiments 4 and 6. I argue that default own-race (i.e., configural) processing is engaged in when participants are given a "deep" incidental task (judging the likeability of the face). In addition, to provide converging evidence on the recruitment of different face processing strategies under intentional versus incidental encoding, as race and university group assignments varied, I manipulated whether faces were upright or inverted at encoding and test (see Maurer, Le Grand, & Mondloch, 2002; Experiments 4 and 6). If there is strong configural coding and relatively poor coding of other features (e.g., under deep but incidental encoding conditions), then strong inversion effects should emerge on stimuli coded configurally. If there is strong coding not only of facial configurations but also of facial features, as might arise under intentional memory conditions, then inversion effects may be weaker.

Although most investigations of the own-race effect do not report analyses of criterion/bias, I conducted these analyses for exploratory purposes. Although in laboratory settings there are no real consequences of misses and false alarms, it seemed reasonable that the psychological consequences of ingroup/outgroup membership would still influence participants' behaviour. In particular, I drew on the "ingroup over-exclusion effect" (Leyens & Yzerbyt, 1992; Yzerbyt, Leyens, & Bellour, 1995), which hypothesises that the motivation to protect one's own identity leads to a tendency to exclude from the ingroup any individuals whose group membership is at all in doubt—in other words, to adopt a more stringent criterion for accepting individuals as ingroup members. I therefore predicted that participants would adopt more conservative criterion for own-race than other-race faces and for own-university than other-university faces. Whether these factors would interact was unclear.

# 2 Experiment 3

In Experiment 3, I examined White participants' memory for own-university and other-university, own-race and other-race faces after memory-directed (i.e., intentional)encoding. Shriver et al. (2008) presented participants with ingroup- and outgroup-categorised own-race and other-race faces in an intentional memory task, and found that participants exhibited greater recognition accuracy for ingroup- than outgroup-categorised own-race, but not other-race, targets. Following Shriver et al., I therefore predicted that for own-race faces, recognition memory would favour ingroup over outgroup targets, but that for other-race faces, ingroup/outgroup categorisation would have no effect.

## 2.1 Method

**2.1.1 Participants and design.** Thirty White students from the University of Birmingham (27 female; $M_{age}$ = 19.2 years) completed the study for course credit; all had normal or corrected-to-normal vision. The experiment was based on a 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) within-participants design.

**2.1.2 Materials.** The materials were as in Chapter 2. The stimuli were divided into sets such that across participants, each face appeared as an ingroup member for some participants but an outgroup member for others, and as a recognition target for some participants but a foil for others. In each set, there were 160 faces (80 Black, 80 White; 80 targets, 80 foils).

**2.1.3 Procedure.** After providing informed consent, participants completed a short task designed to enhance their identification to their ingroup (University of Birmingham), as in Experiments 1–2. Specifically, participants completed a brief questionnaire, ostensibly from university student services, in which they reported five ways in which they were similar to their fellow University of Birmingham students.

Participants then completed the main task; all instructions and stimuli were presented via a personal computer running MediaLab and DirectRT research software (Empirisoft Corporation, 2008). Participants learned that they would take part in a face recognition task with separate learning and recognition phases. They learned further that during the task, they would see faces of students from either the University of Birmingham or the University of Nottingham. They learned on each trial of the task, they would see one face and that their task was to attend closely to all of the faces to recognise them later. Trials were initiated with the presentation of a fixation cross for 500 ms, followed by the ingroup/outgroup prime that appeared centred at the top of the screen for 1500 ms. A face then appeared, centred on the screen below the prime for 2000 ms (see Figure 4). The intertrial interval was 1000 ms. Eighty faces in total were presented (20 for each same-/other-race × same-/other-university category).

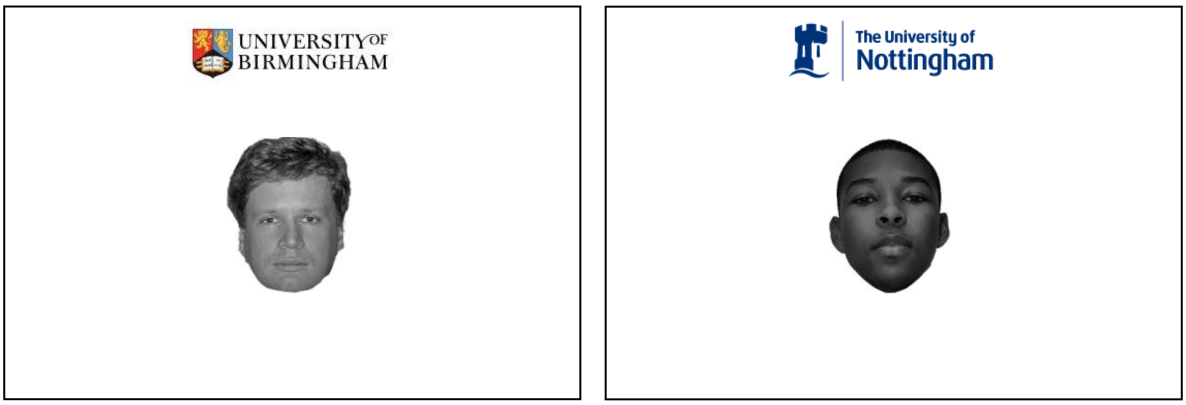


***Figure 4*. Example stimuli, Experiments 3–6. Left panel: own race, own university; right panel: other race, other university.**

Following a brief filler task, participants completed the old/new recognition test. Participants indicated, by means of a key press, whether each face had been presented in the target learning phase. The stimuli included the 80 previously presented faces plus 80 foil images (40 Black, 40 White). Faces were presented centrally on the computer screen below the own-university or other-university prime. "Old" faces were presented with their original primes; and "new" faces were paired quasi-randomly with the own-university or other-university prime (with the only condition that 40 faces were presented with the own-university prime and 40 with the other-university prime). After responses to each face, participants rated their confidence in their memory response along a 7-point scale anchored by 1 (*not at all confident*) and to 7 (*extremely confident*). All stimuli were presented in a randomised order.

Finally, participants completed an adapted inter-racial contact questionnaire (Hancock & Rhodes, 2008; see Appendix H). Participants indicated the extent to which they agreed with each of 15 items concerning their experience with Black targets (e.g., "I know lots of Black people"; 8 items; Cronbach's $\alpha$ = .77) and White targets (e.g., "I interact with White people on a daily basis"; 7 items; Cronbach's $\alpha$ = .30). Ratings were made along a 6-point scale anchored by *very strongly disagree* to *very strongly agree*.

## 2.2 Results

**2.2.1 Recognition memory.** The primary dependent variable of interest was recognition accuracy, analysed using a signal detection framework (Macmillan & Creelman, 1991). Hit and false alarm rates were calculated separately for each of the Target Race × Target University conditions, and these rates were then used to calculate discrimination sensitivity (*d'*) and criterion/bias (*C*) parameters.[11] Participants' *d'* and *C* scores were

[11] After converting frequencies to probabilities, probability values of 1 were replaced with .95 (or (N-1)/N, where N denotes the number of targets) and probabilities of 0 were replaced with .05 (or 1/N, where N denotes the number of foils); this correction is necessary for the accurate calculation of *d*' (cf. Macmillan & Creelman, 1991) and was used throughout the recognition studies within this thesis

submitted to 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) repeated-measures ANOVAs.

***2.2.1.1 Recognition sensitivity.*** Condition means and the ANOVA summary table are presented in Appendix I. The analysis revealed a significant main effect of target race, $F(1, 29) = 6.20$, $p = .02$, $\eta_p^2 = .18$, such that participants demonstrated greater recognition sensitivity for own-race than other-race faces (*M*s = 1.55 and 1.07, respectively). There was also a main effect of target university, $F(1, 29) = 8.50$, $p = .007$, $\eta_p^2 = .23$, such that participants demonstrated greater recognition sensitivity for own-university than other-university targets (*M*s = 1.52 and 1.10, respectively).

As predicted, these two effects were subsumed within a significant Target Race × Target University interaction, $F(1, 29) = 6.97$, $p = .013$, $\eta_p^2 = .19$ (see Figure 5). For own-race targets, recognition sensitivity favoured own-university over other-university targets, $t(29) = 4.47$, $p < .001$. In contrast, for other-race faces, recognition sensitivity was equivalent for own-university and other-university targets, $t(29) = 0.07$, $p = .94$.

***2.2.1.2 Criterion/bias.*** Condition means and the ANOVA summary table are presented in Appendix J. The analysis demonstrated a main effect of target race only, $F(1, 29) = 24.36$, $p < .001$, $\eta_p^2 = .46$, demonstrating that participants adopted a liberal criterion when responding to other-race faces but a more conservative criterion to own-race faces (*Ms* = -.26, and .25, respectively). No other results were significant (all *p*s > .79).

**2.2.2 Confidence ratings.** Participants' confidence ratings were analysed in a Target Race × Target University ANOVA. Condition means and the ANOVA summary table are presented in Appendix K The analysis demonstrated only a significant main effect of target race, $F\ (1, 29) = 10.29$, $p = .003$, $\eta_p^2 = .26$, demonstrating that participants were more confident in their memory for own-race than other-race faces (*Ms* = 4.5 and 4.8, respectively).

**2.2.3 Inter-racial contact.** Inter-racial contact was calculated by averaging across the items pertaining to participants' experience with other-race targets (Cronbach's alpha = .77). A correlational analysis (Spearman's rho) with recognition sensitivity, criterion/bias, and confidence ratings for each condition of the experiment revealed no significant correlations (all *p*s > .11), suggesting that patterns of recognition sensitivity and criterion/bias cannot be explained by differences in inter-racial experience (see Appendix L).

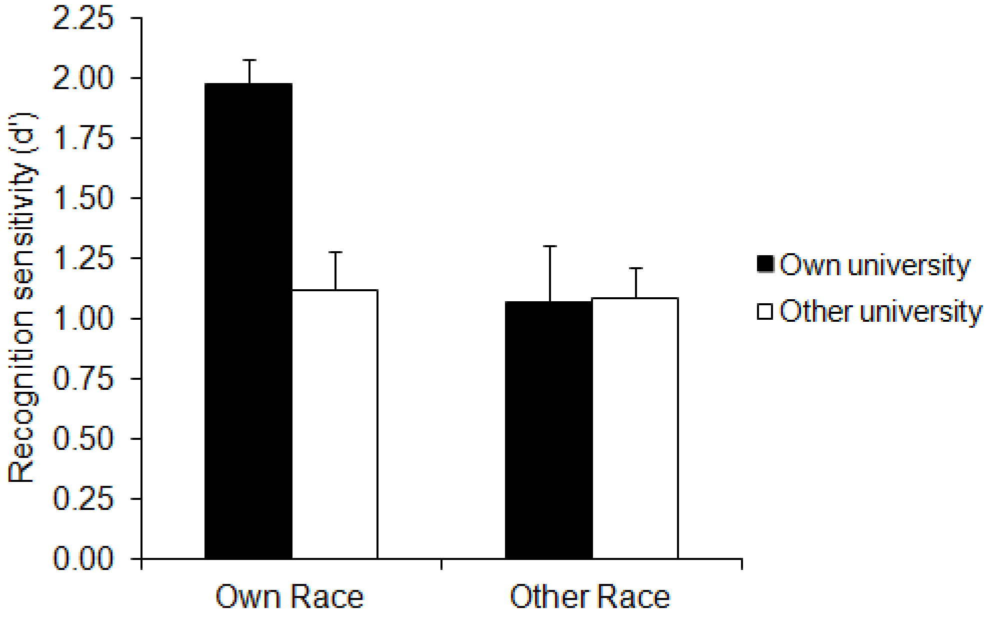


***Figure 5*. Recognition sensitivity (*d'*) as a function of target race and university, Experiment 3 (intentional memory).** *Note.* Error bars represent standard error.

## 2.3 Discussion

The current experiment replicated the typical other-race effect. It also replicated the results of Shriver et al. (2008), in that ingroup/outgroup categorisation exerted an effect on own-race but not other-race faces. Specifically, own-race faces were remembered better when they were categorised as ingroup rather than outgroup members. This suggests that changes in ingroup/outgroup categorisation are sufficient to alter the strength of face memory, even for own-race faces with which we have considerable perceptual experience (Bernstein et al., 2007), and fits with the idea that category-level processing of own-race faces can be dominant under intentional memory conditions. In contrast, I found no effects for ingroup/outgroup categorisation with other-race faces; this may be because other-race targets are typically processed categorically as outgroup members (Hugenberg & Sacco, 2008), particularly in inter-racial contexts (Cassidy et al., 2011). It remained unclear, however, whether the observed ingroup/outgroup categorisation effects were a function of memory-directed encoding.; in Experiment 4, I investigated whether the effects would generalise to a situation in which memory was incidental rather than intentional, where initial processing was directed toward deeper encoding.

## 3. Experiment 4

Experiment 4 examined participants' incidental memory for own-race and other-race faces as a function of ingroup/outgroup categorisation. More specifically, participants judged faces for likeability an arguably "deep" encoding task, which has previously been demonstrated to have consequences for recognition memory, and the engagement of configural/ individuated face processing (e.g., Marzi & Viggiano, 2010; McKelvie, 1985, 1995, 1996), prior to completing a surprise recognition test. I predicted that participants would exhibit better recognition memory for own-race versus other-race faces (i.e., the typical other-race effect). I also predicted that ingroup/outgroup categorisation and racial category membership would interact, but that the specific pattern would differ from that found in Experiment 3. Specifically, I predicted that in the absence of intentional memory goal that may be sensitive to category-level processes (and thus reduced reliance on configural processing) for own-race faces, ingroup/outgroup categorisation would have a greater (rather than a lesser) impact for other- than own-race faces. That is, ingroup/outgroup categorisation was expected to influence memory for other-race faces, because ingroup categorisation would motivate participants to process other-race faces more deeply (Brewer et al., 1995), enabling ingroup/outgroup effects to emerge. Ingroup/outgroup categorisation was not expected to influence memory for own-race faces, however. Although it should be the case that ingroup categorisation should be as motivating in relation to own- than other-race faces, I reasoned that this ingroup motivational advantage would be offset by extensive experience in processing own-race faces configurally and the bias to categorise own-race faces as ingroup members (both of which could offset contextual cues to outgroup membership). .

**3.1 Method**

**3.1.1 Participants and design.** Twenty-six White female students from the University of Birmingham ($M_{age}$ = 18.5 years) completed the study for course credit; all had normal or corrected-to-normal vision. The experiment was based on the same 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) within-participants design, as Experiment 3.

**3.1.2 Materials.** The materials were as in Experiment 3.

**3.1.3 Procedure.** Participants first completed the same identification-enhancing task described in Experiment 1. Participants then completed a likeability judgement task; all instructions and stimuli were presented via a personal computer running MediaLab and DirectRT research software (Empirisoft Corporation, 2006). Participants learned that during the task they would see faces of students from either the University of Birmingham or the University of Nottingham. They learned further than on each trial, they would see one face and that their task was to indicate how likeable they judged each face to be. Trials comprised of a fixation cross for 500 ms, an ingroup/outgroup prime that appeared centred at the top of the screen for 1500 ms, and a target face that appeared centred on the screen below the prime. The ingroup/outgroup prime and target face remained onscreen until participants produced a likeability judgement between 1 (*not at all likeable*) to 7 (*very likeable*). The intertrial interval was 1000 ms. A total of 80 faces were presented (20 for each own-/other-race × own-/other-university category).

Following a brief filler task, participants completed a surprise old/new recognition test, which followed the same procedure as in Experiment 1. On task completion, participants completed the Voci and Hewstone (2003) inter-racial contact questionnaire.

### 3.2 Results

Data were treated as in Experiment 3.

**3.2.1 Likeability judgements.** Participants' likeability ratings and rating times were submitted to 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) repeated-measures ANOVAs

***3.2.1.1 Ratings.*** Condition means and the ANOVA summary table are presented in Appendix M. The analysis revealed a significant main effect of target race, $F(1, 25) = 49.65$, $p < .001$, $\eta_p^2 = .66$, such that own-race faces were judged more likeable than other-race faces (*Ms* = 4.31 and 3.29, respectively). The analysis also revealed a significant main effect of target university, $F(1,25) = 4.57$, $p = .043$, $\eta_p^2 = .15$, such that own-university faces were judged as more likeable than other-university faces (*Ms* = 3.89 and 3.71, respectively).

The Target Race × Target University interaction, however, was not significant, $F(1, 25) = 2.94$, $p = .099$. Although there is evidence for a relationship between liking and memory (Vokey & Read, 1992), this lack of interaction suggests that likeability cannot account for the pattern of recognition memory reported subsequently.

***3.2.1.2 Rating times.*** Due to the presence of outlying responses in the data set, response times over 2.5 standard deviations from the mean were excluded (1.25 % of the data). Condition means and the ANOVA summary table are presented in Appendix N. The analysis revealed no significant main effects or interactions, all *p*s > .32, suggesting that the differences that emerged in recognition memory as a function of these factors could not be attributed to differential viewing times.

**3.2.2 Recognition memory.** Participants' *d'* and *C* scores were submitted to 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) repeated-measures ANOVAs.

***3.2.2.1 Recognition sensitivity.*** Condition means and the ANOVA summary table are presented in Appendix O. The analysis revealed a significant main effect of target race, $F(1, 25) = 33.40$, $p < .001$, $\eta_p^2 = 57$, demonstrating recognition sensitivity was higher for own-race than other-race faces (*Ms* = 1.71 and 0.67, respectively). There was also a significant main effect of target university, $F(1, 25) = 7.41$, $p = .012$, $\eta_p^2 = .23$, demonstrating recognition sensitivity was higher for own-university than other-university targets (*Ms* = 1.40 and 0.97, respectively). Paralleling the effects on target likeability ratings, this pattern suggests that likeable targets are better recognised.

Importantly, these two factors were subsumed within a significant Target Race × Target University interaction, $F(1, 25) = 4.56$, $p = .043$, $\eta_p^2 = 15$ (see Figure 6). Although recognition sensitivity for own-race faces was equivalent for own-university and other-university targets (*M*s = 1.77 and 1.65, respectively; $t(25) = 0.65$, $p = .52$); for other-race faces, recognition sensitivity was greater for own-university than other-university targets (*M*s = 1.03 and 0.28, respectively; $t(25) = 2.88$, $p = .008$).

***3.2.2.2 Criterion/bias.*** Condition means and the ANOVA summary table are presented in Appendix P. The analysis again demonstrated a significant effect of target race, $F(1, 25) = 27.54$, $p < .001$, $\eta_p^2 = .52$, revealing that participants adopted a more liberal criterion for other-race faces, but a more conservative criterion for own-race faces (*M*s = -0.59 and -0.27, respectively).

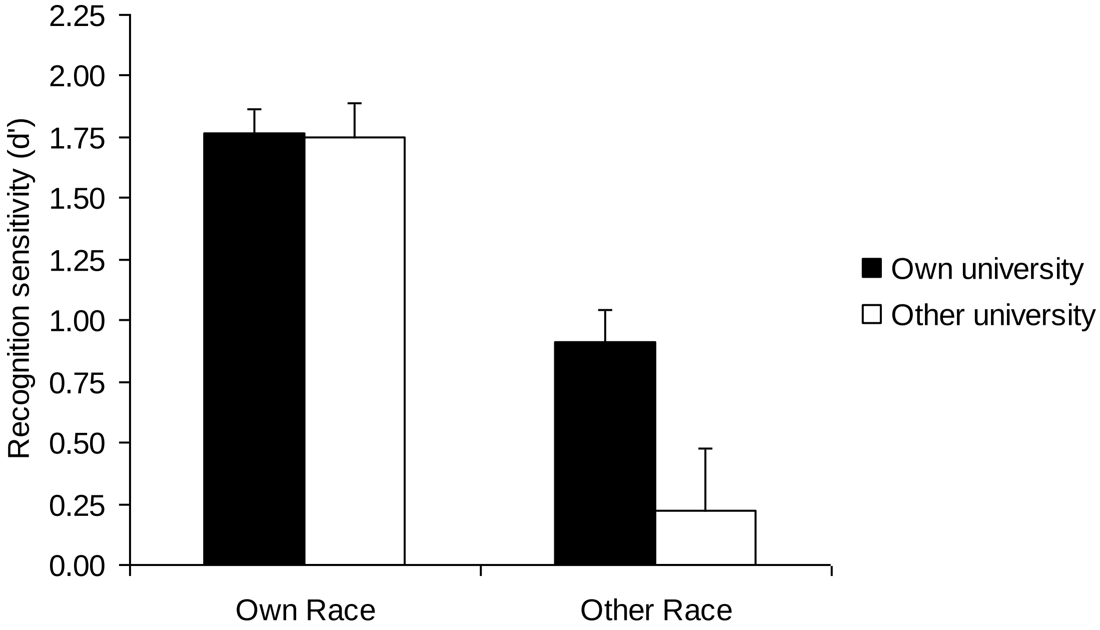


***Figure 6.* Recognition sensitivity (*d'*) as a function of target race and university, Experiment 4 (incidental memory).** *Note.* Error bars represent standard error.

The analysis also revealed a significant Target Race × Target University interaction, $F(1, 25) = 14.33$, $p = .001$, $\eta_p^2 = 36$ (see Figure 7). For own-race faces, participants adopted a more conservative threshold for other-university than own-university targets (*M*s = 0.36, and 0.19, respectively; $t(25) = 2.18$, $p = .039$). For other-race faces, participants adopted a liberal criterion for both other-university and own-university targets, however, participants adopted a significantly more liberal criterion for other-university than own-university targets (*M*s = -0.86 and -0.33, respectively; $t(25) = 3.07$, $p = .005$).

**3.2.3 Inter-racial contact.** Separate scores for quantity and quality of inter-racial contact were calculated by averaging across the items separately for each subscale of the contact questionnaire (Cronbach's alphas = .70 and .82 respectively).

Recognition sensitivity and criterion bias scores for other-race faces, as a function of university affiliation, were submitted to a correlational analysis (Spearman's rho) with participants' self-reported quantity and quality of inter-racial contact. The analysis revealed no significant correlations (all *p*s > .26; see Appendix Q). Again, any results are therefore unlikely to be explained by differences in inter-racial experience.

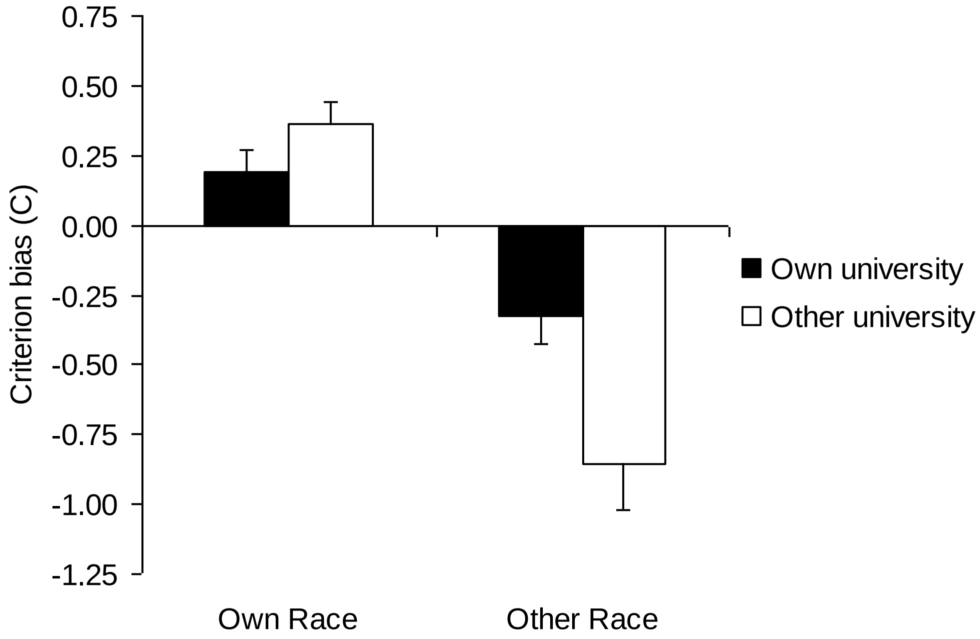


***Figure 7*. Criterion/bias (*C*) as a function of target race and university, Experiment 4.**
*Note*. Error bars represent standard error.

**3.2.4 Post hoc analyses.** Because likeability has sometimes been linked with greater recognition (e.g., Vokey & Read, 1992), Spearman's rho correlations between likeability ratings and recognition were calculated. The analysis revealed no significant correlations between likeability and recognition sensitivity (all *p*s > .16; see Appendix R).

Because the time spent judging likeability at encoding could have influenced recognition, Spearman's rho correlations between rating time at encoding and recognition sensitivity were also calculated. Again the results demonstrated no significant correlations between rating time and subsequent recognition (all *p*s > .11; see Appendix S). In summary, the recognition results cannot be explained in terms of likeability ratings or viewing time at encoding.

**3.3 Discussion**

Experiment 4 investigated the effect of ingroup/outgroup categorisation on memory for own-race and other-race faces among participants who judged faces for likeability, rather than encoding faces for later recognition. As in Experiment 3, recognition memory was better for own-race than other-race faces; that is, I replicated the typical other-race effect. In contrast to Experiment 3 (and past research; e.g., Bernstein et al., 2007; Shriver et al., 2008), however, ingroup/outgroup categorisation exerted an effect on other-race but not own-race recognition. Specifically, other-race faces categorised as ingroup members were remembered better than those categorised as outgroup members, but there was no evidence that ingroup/outgroup categorisation modulated own-race face recognition.

The failure to observe ingroup/outgroup categorisation effects for own-race faces following trait-directed incidental, as opposed to memory-directed, encoding suggests that performance here was affected by a default process for own-race faces irrespective of the assignment of the non-racial group. I suggest that this default reflects configural coding; this will be tested in Experiment 6. Ingroup categorisation did have an effect on the recognition of other-race faces, so it cannot be argued that the ingroup/outgroup categorisation was simply not applied during trait-directed encoding. Moreover, participants also gave higher likeability ratings for ingroup than outgroup faces, regardless of race, again corroborating the effectiveness of the ingroup/outgroup manipulation. Rather than ingroup/outgroup categorisation failing to exert any motivational influence, the results suggest that in the absence of memory-directed encoding to remember faces, all own-race faces are treated similarly—perhaps by all being categorised as ingroup members at some level. This reasoning is in line with the hypothesis that racial categorisation is a default process that is engaged even when a task does not explicitly require categorisation (Allport, 1954; Brewer, 1988; Devine, 1989; Fiske & Neuberg, 1990; but see Cassidy et al., 2011; Hehman et al., 2010). That ingroup categorisation exerted a greater influence on other-race faces suggests that this default processing strategy was carried over to other-race faces assigned to the participant's social group, at least under deep encoding conditions.

**3.3.1 Incidental versus intentional memory.** The results of Experiments 3 and 4 together thus suggest that different encoding goals can yield very different memorial outcomes. Given that the participants in Experiments 3 and 4 came from the same population (university, cohort) and were demographically similar (in race, sex, age), I conducted an exploratory analysis in which I combined the data from the two experiments. I conducted a Target Race (own-race/other-race) × Target University (own-university/other-university) × Memory Type (intentional/incidental) mixed-model ANOVA with memory type as a between-participants factor. This analysis yielded a significant Target Race × Target University × Memory Type interaction, $F(1, 54) = 11.23$, $p = .001$, $\eta_p^2 = .17$. For own-race targets, the Target University × Memory Type interaction ($F(1, 54) = 8.51$, $p = .005$, $\eta_p^2 = .14$) was explained by the fact that ingroup categorisation improved recognition among participants *with* an intentional memory goal, $t(54) = 2.52$, $p = .013$. This may reflect processes recruited over and above the default encoding applied to own-race faces. For other-race targets, the Target University × Memory Type interaction was also significant ($F(1, 54) = 4.65$, $p = .036$, $\eta_p^2 = .080$). In this case, ingroup categorisation of other-race faces improved recognition among participants , $t(54) = 3.05$, $p = .004$. This is consistent with extra processes being recruited for the other-race, ingroup-categorised faces than would normally be the case.

Interestingly, for other-race targets, there was also a strong effect of encoding goal, $F(1, 54) = 4.93$, $p = .047$, $\eta_p^2 = .071$, such that recognition was better following intentional than incidental learning (*M*s = 1.08 and 0.66, respectively). This pattern is in line with the assertion that individuation motives are constrained by individuation experience with other-race faces (Hugenberg et al., 2010; see also Rossion & Michel, 2011). Presumably deeper encoding (more akin to own-race processing) resulted in participants applying own-race face processing strategies to other-race faces, but with the result of extracting "faulty" or inappropriate cues for other-race recognition (Davies, Ellis, & Shepherd, 1977; Ellis, Deregowski, & Shepherd, 1975; Schyns, Bonnar, & Gosselin, 2002; Sergent, 1984; Valentine & Endo, 1992), especially for ingroup-categorised other-race targets.

# 4 Experiment 5

In Experiment 5, I set out to test whether the effects observed in Experiment 3, under memory-directed encoding, were the result of differential reliance on configural processing for own- and other-race faces. I introduced inverted faces, as well as upright faces, in an intentional memory task, and used inversion costs (i.e., poorer recognition of inverted than upright faces) as a marker of configural processing (Diamond & Carey, 1986; Maurer et al., 2002; Thompson, 1980; Yin, 1969). In line with Experiment 3, I predicted that racial and non-racial categorisation would interact, such that ingroup/outgroup categorisation would have a greater impact on recognition memory for own-race than other-race faces due to the impact of category-level processes on own-race outgroup faces.

In terms of processing, I reasoned that if intentional memory goals are more akin to category-level, feature-based coding (cf. Mason & Macrae, 2004), and therefore rely less upon "normal" configural processing, than inversion effects are likely be relatively weak. Although there is overwhelming evidence that inversion is detrimental to face processing (e.g., Diamond & Carey, 1986; Thompson, 1980; Yin, 1969), there is some prior evidence for weak effects of configural coding when category-level processing of faces is emphasised, even for own-race faces. Hugenberg and Corneille (2009) tested for configural processes using the face-composite effect (Young et al., 1987). Hugenberg and Corneille failed to find a face-composite effect for own-race faces when those faces were categorized as outgroup members, and speculated that the lack of face-composite effect in their study arose from participants' decreased motivation to attend to outgroup members. It is also possible, however, that the null effect was driven by less reliance on configural information in the outgroup faces. Face-composite effects reflect "holistic" rather than configural encoding but, importantly, for both inversion and face-composite paradigms, a lack of effect suggests relatively less reliance on configural processing. I therefore predicted that there would be a lack of reliance on configural processing across all conditions in Experiment 5.

## 4.1 Method

**4.1.1 Participants and design.** Thirty-nine White students from the University of Birmingham (35 female; $M_{age}$ = 19.6 years) completed the study for course credit; all participants had normal or corrected-to-normal vision. The experiment was based on a 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) × 2 (target orientation: upright/inverted) within-participants design.

**4.1.2 Materials.** The materials were the same face as in Experiment 3 and 4, with the exception that half of the faces were inverted (i.e., rotated 180°). Across participants, each face appeared upright for some participants and inverted for others. Faces were always presented in the same orientation at encoding and test.

**4.1.3 Procedure.** The procedure was as in Experiment 3, with the exception that participants did not rate their confidence in their memory responses and completed the inter-racial contact questionnaire described in Experiment 1 (Voci & Hewstone, 2003).

## 4.2 Results

**4.2.1 Recognition memory.** The data were treated as Experiment 3. Hit and false alarm rates were calculated separately for each of the Target Race × Target University conditions, and these rates were then used to calculate discrimination sensitivity (*d'*) and criterion/bias (*C*). Participants *d'* and *C* scores were submitted to 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) × 2 (target orientation: upright/inverted) repeated-measures ANOVAs.

***4.2.1.1 Recognition sensitivity.*** Condition means and the ANOVA summary tables are presented in Appendix T. The analysis revealed a significant main effect of target race, $F(1, 38) = 16.07$, $p < .001$, $\eta_p^2 = .29$, with greater recognition sensitivity for own-race than other-race faces (*M*s = 1.35 and 0.89, respectively). The analysis also revealed a significant Target Race × Target University interaction, $F(1, 38) = 23.75$, $p < .001$, $\eta_p^2 = .38$ which was subsumed within a Target Race × Target University × Target Orientation interaction, $F(1, 38) = 5.43$, $p = .025$, $\eta_p^2 = .12$ (see Figure 8).

This interaction was analysed further by conducting separate Target University × Target Orientation ANOVAs for each target race. For own-race targets, there was a main effect of target university only, $F(1, 38) = 5.08$, $p = .030$, $\eta_p^2 = .12$, with stronger recognition sensitivity for own-university than other-university targets (*M*s = 1.50 and 1.20, respectively). Of particular note, there was no effect of inversion, $F(1, 38) = 0.24$, $p = .62$, $\eta_p^2 = .01$.

For other-race targets, there was a main effect of target university, $F(1, 38) = 8.52$, $p = .006$, $\eta_p^2 = .18$, with paradoxically stronger recognition sensitivity for other-university than

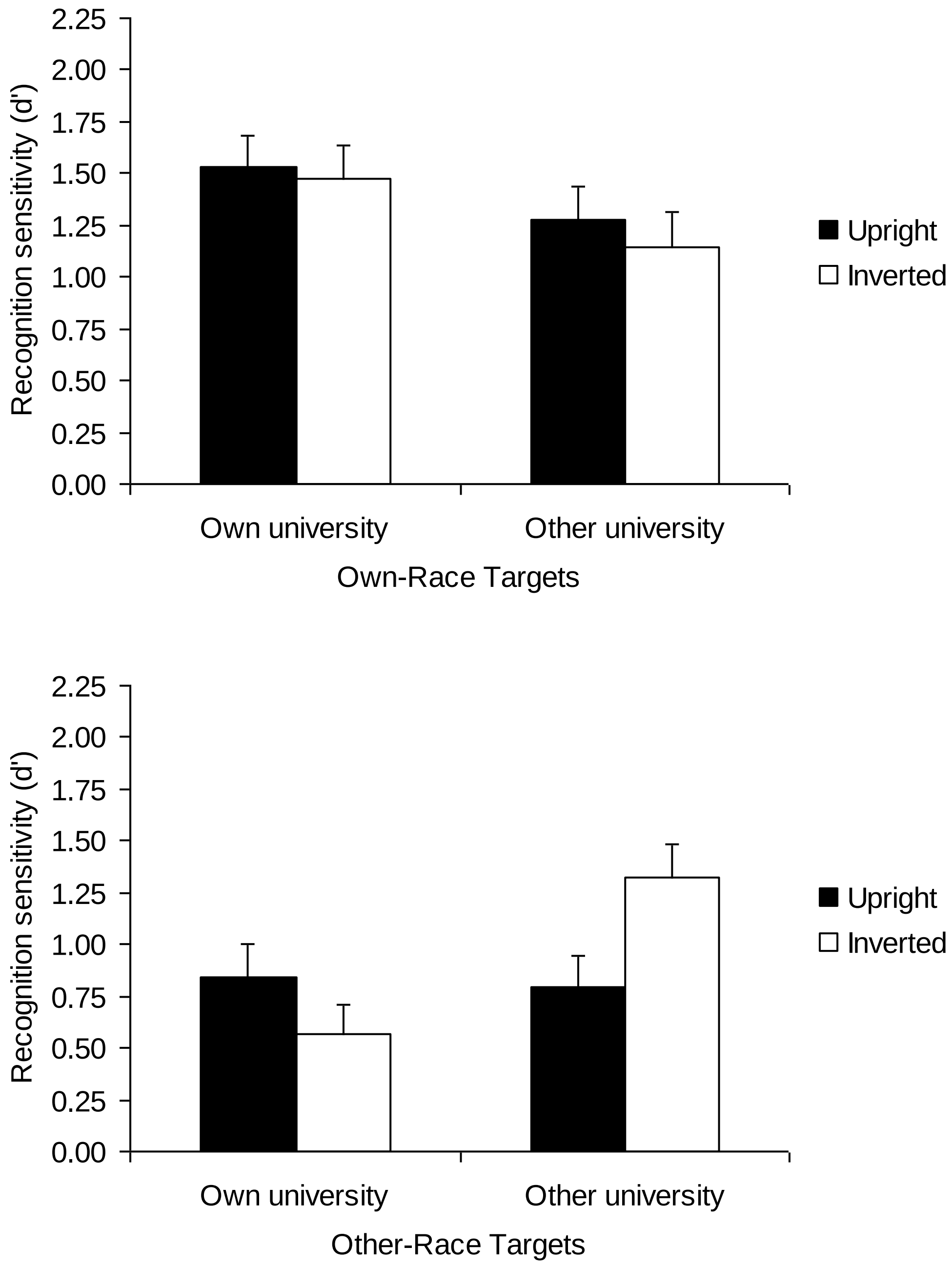


***Figure 8*. Recognition sensitivity (*d'*) as a function of target race, university, and orientation, Experiment 5.** *Note.* Error bars represent standard error.

own-university targets (*M*s = 1.09 and 0.70, respectively). This effect was subsumed within a Target University × Target Orientation interaction, $F(1, 38) = 9.07$, $p = .005$, $\eta_p^2 = .19$. For own-university targets, recognition sensitivity was equivalent for inverted and upright targets, $t(38) = 1.50$, $p = .14$; that is, there was no inversion effect. For other-university targets, however, the standard inversion effect was reversed; recognition sensitivity was stronger for inverted than upright targets, $t(38) = 2.62$, $p = .013$.

For exploratory purposes, I also conducted *t*-tests to examine whether the results for the upright targets replicated the findings of Experiment 3 (and those of Shriver et al., 2008). Indeed, I again found that for own-race targets, participants demonstrated better recognition sensitivity for own-university than other-university targets, $t(38) = 1.68$, $p = .05$, but that for other-race targets, university status exerted no impact, $t(38) = 1.68$, $p = .39$.

***4.2.1.1 Criterion/bias.*** Condition means and the ANOVA summary table are presented in Appendix U. The analysis demonstrated a number of significant main effects: There was a main effect of target race, $F(1, 38) = 15.14$, $p < .001$, $\eta_p^2 = .29$, indicating that participants adopted a more liberal criterion for other-race targets but a more conservative criterion for own-race targets (*M*s = -0.16 and 0.16, respectively); and a main effect of target university, $F(1, 38) = 6.54$, $p = .015$, $\eta_p^2 = .15$, indicating that participants adopted a more liberal criterion for own-university but a more conservative criterion for other-university targets (*Ms* = -0.07 and 0.07, respectively). These main effects were subsumed within a significant Target Race × Target University interaction, $F(1, 38) = 8.23$, $p = .007$, $\eta_p^2 = .18$ (see Figure 9). Inspection of the means demonstrated that for other-race faces, participants adopted a more liberal criterion for own-university targets relative to other-university targets (*M*s = -0.32 and 0.01, respectively; $t(39) = 3.61$, $p = .002$) but no response bias for other-university targets, $t(38) = 0.12$, $p = .90$. In contrast, for own-race faces, participants demonstrated a conservative criterion irrespective of own-university or other-university status (*M*s = 0.17 and 0.14, respectively, $t(38) = 0.36$, $p = .72$).

The analysis also revealed several effects involving target orientation. These effects were theoretically uninterpretable, because they do not relate clearly to how one might be motivated to protect ingroup identity. Therefore, these results were not analysed further.

**4.2.2 Inter-racial contact.** Separate scores for quantity and quality of inter-racial contact were calculated by averaging across the items separately for each subscale of the contact questionnaire (Cronbach's alphas = .85 and .80, respectively). Correlational analysis (Spearman's rho) revealed no significant correlations between either the quantity or quality of contact (all *p*s > .39) and inversion costs for either own- or other-university other-race faces (see Appendix V). The aforementioned recognition sensitivity results are therefore not explained by simple differences in racial experience.

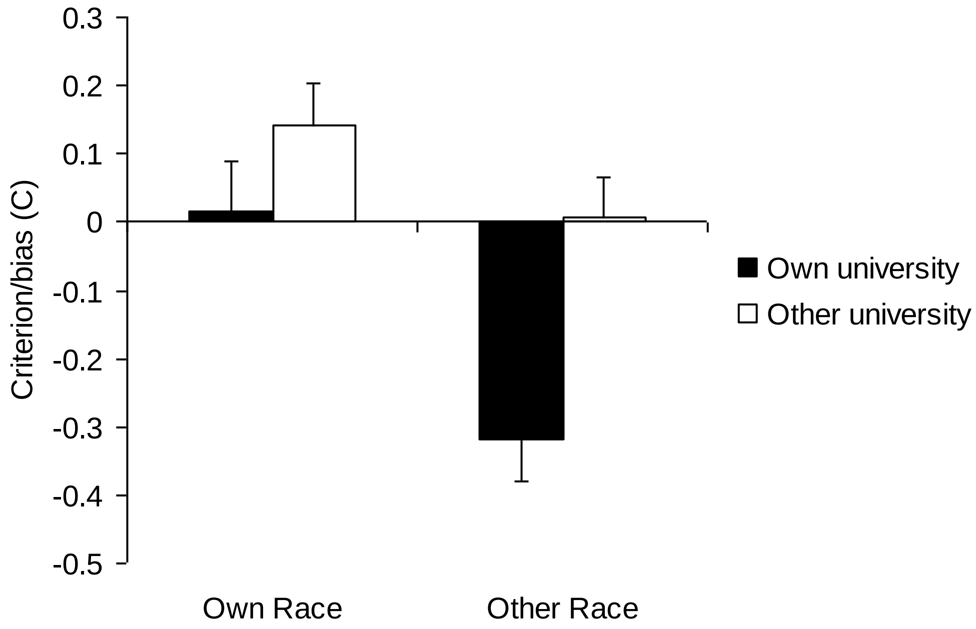


***Figure 9*. Criterion/bias (*C*) as a function of target race and university, Experiment 5.**
*Note.* Error bars represent standard error.

## 4.3 Discussion

The current experiment yielded several results of interest. First, own-race faces were generally remembered better than other-race faces (i.e., the other-race effect). Second, replicating the effects of Experiment 3 (see also Bernstein et al., 2007, Shriver et al., 2008), ingroup categorisation, relative to outgroup categorisation, benefitted recognition memory for own-race faces. Third, there were minimal effects of ingroup/outgroup categorisation for other-race faces when the faces were presented upright (see also Experiment 3). Fourth, the effects of inversion were generally weak, with only non-significant trends for an upright memory advantage (for own-race faces and ingroup-categorised other-race faces). Finally, there was a reversal of the standard face inversion effect when other-race faces were categorised as outgroup members, such that inverted other-race faces were better recognised than upright other-race faces when categorised as outgroup members.

The weak inversion effects observed for own-race faces and ingroup-categorised other-race faces is consistent with participants engaging in category-level as well as individuated coding of faces, with category-level encoding less sensitive to inversion than individuated (configurally encoded) representations.

The most surprising finding was that inversion benefitted the recognition of outgroup-categorised other-race faces. This result is noteworthy given the overwhelming evidence for the detrimental effects of inversion on face processing (Diamond & Carey, 1986; Thompson, 1980; Yin, 1969). It is not, however, the first demonstration of this reversed effect of inversion. Young, Hellawell, and Hay (1987, Experiment 2) found a reversal in one of their initial demonstrations of the face-composite effect. They demonstrated not only that this illusion disappeared when face composites were inverted but rather that the illusion reversed—that is, that participants were faster to recognise identical top halves of faces as identical when the faces were inverted rather than upright.

Because good performance on the face-composite task requires *not* attending to configural information, Young et al. concluded that configurations are perceived correctly only in upright faces. The link between attention to configural information and good performance on the face-composite task, however, assumes that the correct configurations are attended in upright faces. There is evidence that White participants encode own-race faces using configural representations of the eyes in relation to the nose and mouth (e.g., Schyns, Bonnar, & Gosselin, 2002; Sergent, 1984), but other evidence suggests that information about the mouth and jaw line might be the most useful for discrimination of Black faces (e.g., Davies, Ellis, & Shepherd, 1977; Ellis, Deregowski, & Shepherd, 1975). Thus, for our White participants, the extraction of the kinds of configural information typically derived from own-race faces might not support the recognition of other-race faces and might actually be detrimental to their recognition. Indeed, when White participants are trained to attend to lower-face features (diagnostic of Black identity) rather than upper-face features (diagnostic of White identity), even when the training is with own-race faces, they show improved other-race recognition (Hills & Lewis, 2006). In the current experiment, however, when other-race faces were categorised as outgroup members, presented in inverted orientation, or encoded with a memory-directed encoding goal—all of which should decrease reliance on configural processing (and perhaps reliance on non-identity-diagnostic configurations)—participants appeared to process the faces more effectively (and especially when all factors are combined).

Elsewhere, there is data reporting an advantage for inverted faces in prosopagnosic patients (de Gelder, Bachoud-Levi, & Degos, 1998; Farah, Wilson, Drain, & Tanaka, 1995). In such cases, the benefit from face inversion has been attributed to patients extracting "noisy" (i.e., inefficient) configural representations from upright faces, which disrupts rather than facilitates recognition when faces are upright; when faces are inverted, patients extract less of this noisy information and show better face recognition. Here I suggest that participants were particularly likely to encode other-race, outgroup faces at a category-level with minimal configural coding, making configural information less available to recognition when faces were inverted.

## 5 Experiment 6

Experiment 6 examined recognition for own- and other-race faces as a function of ingroup/outgroup categorisation and face orientation following trait-directed incidental encoding. As in Experiment 4, participants judged faces for likeability rather than studying faces for later recognition, and then completed a surprise recognition task. In addition, faces were presented in either upright or inverted orientation. I predicted that participants would exhibit better recognition memory for own-race versus other-race faces (i.e., the typical other-race effect). I also predicted, in line with our findings from Experiment 4, that ingroup/outgroup categorisation and racial category membership would interact. I reasoned that in the absence of an intentional memory goal (and any changes in processing that would ensure), own-race faces would be recognised equally well, irrespective of how the faces were categorised (ingroup/outgroup). In contrast, I reasoned that recognition of other-race faces would depend on whether they were categorised as ingroup or outgroup members.

In terms of processing, I expected more robust inversion effects than in Experiment 5, on the assumption that processing in the absence of an explicit memory goal would engage more "deep", individuated (i.e., configural) processing. Ingroup/outgroup categorisation was not expected to influence the magnitude of the inversion cost for own-race faces because perceptual experience with own-race faces and/or a bias to categorise own-race faces as ingroup members should support normal configural processing in all cases. In contrast, ingroup/outgroup categorisation was expected to influence the magnitude of the inversion cost for other-race faces, because ingroup categorisation would motivate participants to process other-race faces more deeply (Brewer et al., 1995). Specifically, I expected inversion costs (i.e., configural processing) to emerge for other-race faces when they were categorised as ingroup but not outgroup members.

## 5.1 Method

**5.1.2 Participants and design.** Thirty-nine White students from the University of Birmingham (31 female; $M_{age}$ = 20.3 years) completed the study for course credit; all had normal or corrected-to-normal vision. The experiment was based on a 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) × 2 (target orientation: upright/inverted) within-participants design.

**5.1.3 Materials and procedure.** The materials and procedure were as in Experiment 3. Participants followed the same procedure as in Experiment 4.

## 5.2 Results

Data were treated as in Experiment 4.

**5.2.1 Likeability judgements.** Participants' likeability ratings and rating times were submitted to 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) × 2 (target orientation: upright/inverted) repeated-measures ANOVA.

***5.2.1.1 Ratings.*** Conditions means and the ANOVA summary table are presented in Appendix W. The analysis revealed a main effect of target race, $F(1, 38) = 40.19$ $p < .001$, $\eta_p^2 = .51$, such that own-race faces were judged more likeable than other-race faces (*Ms* = 4.27 and 3.41, respectively). The analysis also revealed a main effect of target university, $F(1, 38)$

= 11.54, $p$ = .002, $\eta_p^2$ = .23, such that own-university faces were judged more likeable than other-university faces (*Ms* = 3.93 and 3.75, respectively).

These main effects were subsumed within a significant Target University × Target Orientation interaction, $F(1, 38) = 5.78$, $p = .021$, $\eta_p^2$ =.13. For own-university faces, participants rated upright faces as marginally more likeable than inverted targets, $t(38) = 1.94$, $p = .06$ (*Ms* = 4.00 and 3.86, respectively). For other-university faces, however, likeability was equivalent for upright and inverted targets, $t(38) = 0.73$, $p = .47$ (*Ms* = 3.71 and 3.78, respectively). Again, however, there were no higher-order Target Race × Target University interactions, both $F < 0.38$, both $p > .84$, suggesting that likeability could not account for the recognition memory results reported below.

***5.2.1.2 Rating times.*** Mean judgement latencies served as the dependent measure of interest. Due to the presence of outlying responses in the data set, response times over 2.5 standard deviations from the mean were excluded (2.56 % of the data). Condition means are the ANOVA summary table are presented in Appendix X.

The analysis revealed only a significant main effect of target orientation, $F(1, 38)$ = 4.18, $p$ = .048, $\eta_p^2$ = .099, such that participants were slower to make likeability judgements for inverted than upright targets (*M*s = 2254 and 2154 ms, respectively). There were no main or interaction effects for target race or university, all *p*s > .21, suggesting that any differences that emerged in recognition memory as a function of these factors could not be attributed to differential viewing times.

**5.2.2 Recognition memory.** Participants' recognition sensitivity (*d'*) and criterion/bias (*C*) scores were submitted to 2 (target race: own-race/other-race) × 2 (target university: own-university/other-university) × 2 (target orientation: upright/inverted) repeated-measures ANOVAs.

***5.2.2.1 Recognition sensitivity.*** Condition means and the ANOVA summary tables are presented in Appendix Y. The analysis revealed a main effect for target race, $F(1, 38) = 65.66$, $p < .001$, $\eta_p^2 = .63$, with recognition sensitivity higher for own-race than other-race faces (*M*s = 1.59 and 0.90, respectively). This main effect was subsumed by a significant Target Race × Target University × Target Orientation interaction, $F(1, 38) = 4.27$, $p = .046$, $\eta_p^2 = .10$ (see Figure 10), which was analysed further by conducting separate Target University × Target Orientation ANOVAs for each target race.

For own-race faces, there was only a significant main effect of target orientation, $F(1, 38) = 4.16$, $p = .048$, $\eta_p^2 = .09$, such that participants demonstrated better recognition sensitivity for upright than inverted targets (*M*s = 1.77 and 1.40, respectively). For other-race faces, there were significant main effects of target university, $F(1, 38) = 9.34$, $p = .004$, $\eta_p^2 = .19$, and target orientation, $F(1, 38) = 6.49$, $p = .015$, $\eta_p^2 = .15$. These effects were qualified by a Target University × Target Orientation interaction, $F(1, 38) = 5.05$, $p = .031$, $\eta_p^2 = .12$. The inversion cost (i.e., poorer recognition sensitivity for inverted than upright faces) was reliable for own-university targets, $t(38) = 3.86$, $p < .001$, but not for other-university targets, $t(38) = 0.19$, $p = .85$.

***5.2.2.2 Criterion/bias*** Condition means and the ANOVA summary tables are presented in Appendix Z. The analysis demonstrated main effects of target race, $F(1, 38) = 38.24$, $p < .001$, $\eta_p^2 = .50$, indicating that participants adopted a more conservative criterion for own-race than other-race faces (*Ms* = 0.54 and 0.02, respectively); and a main effect target university, $F(1, 38) = 4.14$, $p = .049$, $\eta_p^2 = .10$, indicating that participants adopted a more conservative criterion for other-university than own-university targets (*Ms* = 0.32 and .24, respectively). The analysis also revealed several effects involving target orientation. These effects were theoretically uninterpretable, and so were not analysed further.

**5.2.2 Inter-racial contact.** Separate scores for quantity and quality of inter-racial contact were calculated by averaging across the items separately for each subscale of the contact questionnaire (Cronbach's alphas = .69 and .86, respectively).

Correlational analysis (Spearman's rho) revealed no significant correlations between either the quantity (all *p*s > .60), or quality of contact (all *p*s > .73) and inversion costs for either own- or other-university other-race faces (see Appendix AA). The recognition results are therefore not explained by simple differences in racial experience.

**5.2.3 Post hoc analyses.** Exploratory post hoc analyses were used to investigate other possible contributions to the recognition findings.

***5.2.3.1. Likeability and recognition.*** Because likeability has sometimes been linked with greater recognition (e.g., Vokey & Read, 1992), correlations (Spearman's rho) between likeability ratings and recognition sensitivity were calculated (see Table 4). The analysis revealed significant positive correlations between participants' likeability ratings and recognition sensitivity for inverted own-race, own-university faces, and upright other-race, own-university faces. No other significant correlations were observed.

***5.2.3.2. Encoding time and recognition.*** Because the time spent judging likeability may have influenced recognition memory outcomes, correlations (Spearman's rho) between rating times and recognition sensitivity for each condition (*d'*) were calculated. The analysis demonstrated several significant positive correlations between response time and recognition sensitivity (see Table 5), such that increased response time tended to be related to greater recognition sensitivity. For own-race faces, the analysis revealed significant positive relationships between encoding time and recognition for upright own-university targets and upright other-university targets. For other-race faces, the analysis revealed significant positive relationships between encoding time and recognition for upright own-university targets, upright other-university targets, and inverted other-university targets.

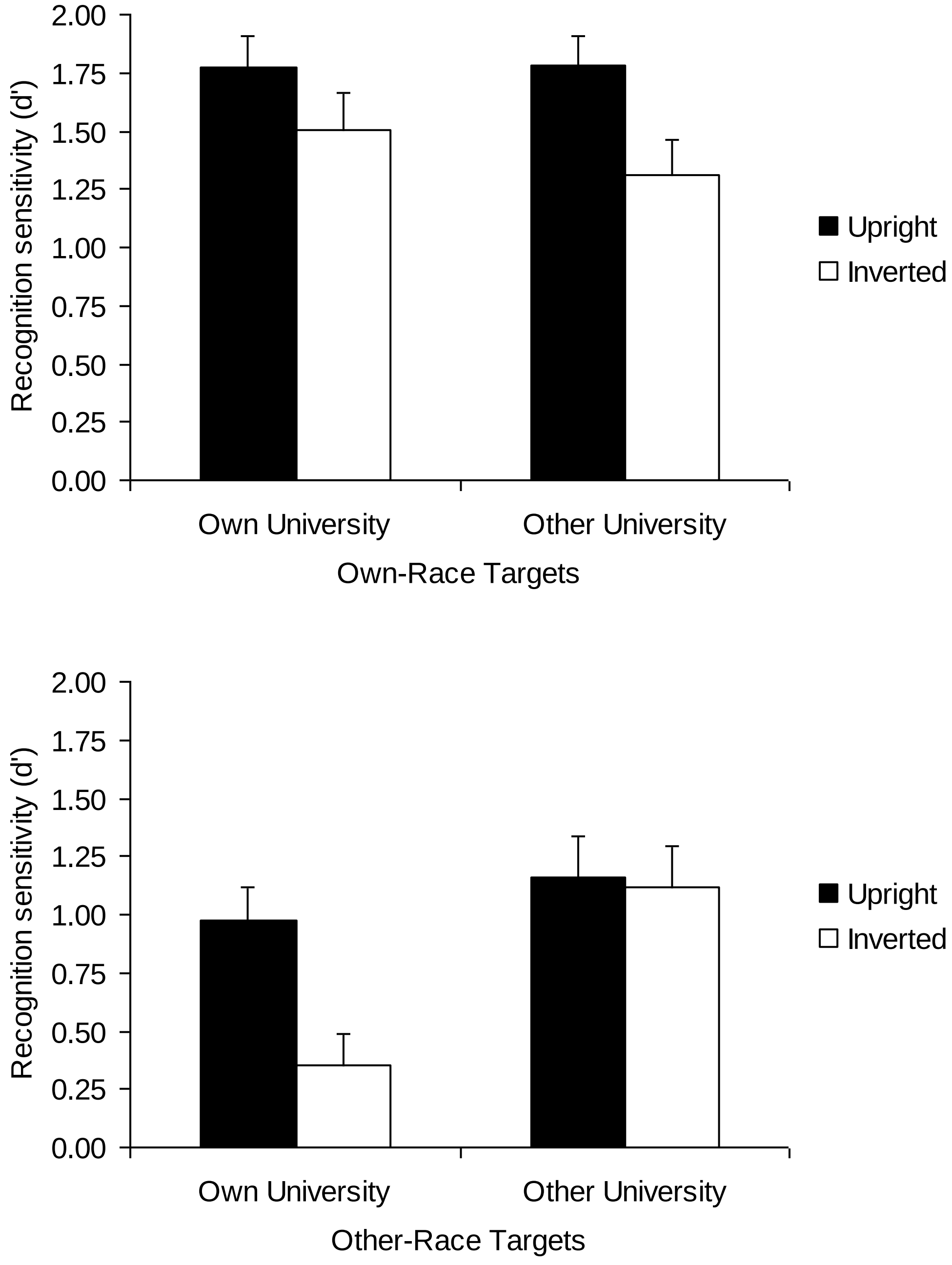


***Figure 10.* Recognition sensitivity (*d'*) as a function of target race, university and orientation, Experiment 6.** *Note.* Error bars denote standard error.

**Table 4**
***Spearman's rho coefficients between likeability ratings and recognition sensitivity (d') as a function of target race, university, and orientation, Experiment 4***

| | Own University (Birmingham) | | | | Other University (Nottingham) | | | |
|---|---|---|---|---|---|---|---|---|
| | Upright | | Inverted | | Upright | | Inverted | |
| | $r_s$ | $p$ | $r_s$ | $p$ | $r_s$ | $p$ | $r_s$ | $p$ |
| Own Race (White) | .17 | .29 | .32 | .05 | .21 | .21 | -.03 | .85 |
| Other Race (Black) | .37 | .02 | .15 | .36 | -.08 | .64 | -.02 | .93 |

*Note*. Two-tailed correlations.

**Table 5**
***Spearman's rho coefficients between encoding time and recognition sensitivity (d') as a function of target race, university, and orientation, Experiment 4***

| | Own University (Birmingham) | | | | Other University (Nottingham) | | | |
|---|---|---|---|---|---|---|---|---|
| | Upright | | Inverted | | Upright | | Inverted | |
| | $r$ | $p$ | $r$ | $p$ | $r$ | $p$ | $r$ | $p$ |
| Own Race (White) | .42 | .008 | -.12 | .48 | .36 | .02 | .30 | .07 |
| Other Race (Black) | .61 | .001 | .24 | .14 | .34 | .04 | .33 | .03 |

*Note*. Two-tailed correlations.

It is worth noting that most of the relationships (except in the case of inverted own-university targets) were significant or approaching significance. In combination with the fact that the pattern does not mirror the recognition sensitivity results (i.e., that "good" memory was evident even in cases where encoding time and recognition were not correlated), this suggests that these correlations reflect a more general relationship between increased viewing time at encoding and subsequent memory. They do not account for the pattern of recognition sensitivity.

**5.3 Discussion**

The current experiment investigated the effects of ingroup/outgroup categorisation on the processing of own-race and other-race faces by participants who encoded faces for likeability in an incidental memory task. There were several findings of interest. First, and as in Experiments 3–5, participants demonstrated better recognition memory for own-race than other-race faces (i.e., the typical other-race effect). Second, for own-race faces, participants demonstrated equivalent recognition sensitivity and inversion costs for ingroup (own-university) and outgroup (other-university) faces, suggesting configural processing of both. Finally, for other-race faces, participants demonstrated better recognition for outgroup (other-university) than ingroup (own-university) faces, but more configural processing for ingroup (own-university) than outgroup (other-university) faces.

The emergence of reliable face inversion effects for own-race faces in Experiment 6 but not in Experiment 4 is consistent with my reasoning that intentional memory encoding prompts reliance on category-based surface coding (in Experiment 3), which is less sensitive to inversion than individuated face encoding. That non-racial ingroup/outgroup status had no impact on processing or memory for own-race faces is inconsistent with the Categorisation–Individuation Model (Hugenberg et al., 2010), which would predict that motivational differences vis-à-vis ingroup and outgroup targets would lead to differences in processing. Instead, this pattern is consistent with my assertion that as long as encoding recruits 'deeper' individuated (i.e., configural) face encoding, then experience with own-race faces ensures that motivational effects have little scope for influence.

For other-race faces, outgroup categorisation resulted in better recognition sensitivity than ingroup categorisation, but this effect was driven by particularly poor recognition of inverted ingroup faces. This poor recognition may stem from configural processing applied to ingroup faces from another race. Other-race faces tend not to be subject to the "normal" configural processing that is believed to underlie accurate face recognition (e.g., Greenberg & MacGregor, 2010; Hancock & Rhodes, 2008; Michel, Caldara, & Rossion, 2006; Michel et al., 2006; Rhodes et al, 1989; Rhodes et al., 2009; Sangrigoli & de Schonen, 2004; Stahl et al., 2008; Tanaka et al., 2004), and so any configural representation extracted for these faces in the deep, incidental memory conditions may be less well specified than the configural representation of own-race faces. Other-race ingroup faces may therefore suffer under conditions of inversion. Perhaps the configurations extracted by participants were inappropriate for other-race faces (Davies et al., 1977; Ellis et al., 1975). Consistent with the Categorisation–Individuation Model, the motivation to individuate ingroup faces appears to have been constrained by a lack of experience in individuating other-race faces.

# 6 General Discussion

The current research investigated how ingroup/outgroup categorisation influences processing of and memory for unambiguous own-race and other-race faces. In addition to the typical other-race effect, there were several findings of interest: First, ingroup/outgroup categorisation exerted different effects on own-race versus other-race face processing, suggesting that the impact of social-categorisation-related motives are constrained by perceptual experience. Second, the effects of race and university categorisation varied according to whether faces were encoded intentionally or incidentally.

## 6.1 Memory Directed Encoding of Own-Race versus Other-Race Faces

In Experiments 3 and 5, as is typical of many investigations of the other-race effect, participants studied ingroup- and outgroup-categorised own-race and other-race faces for later recognition. Under these intentional memory-directed encoding conditions, I replicated past research (e.g., Bernstein et al., 2007; Shriver et al., 2008): For own-race faces, outgroup categorisation impaired recognition relative to ingroup categorisation. This pattern can be accounted for Hugenberg et al.'s (2010) Categorisation–Individuation Model: Own-race faces are assumed to elicit attention to identity-diagnostic information, but situational cues can temporarily direct attention to the category level, which can reduce subsequent recognition accuracy.  The results suggest that category-level information can modulate even own-race face processing under these intentional conditions.

Because category-level encoding is the default for other-race faces, however, the processing of these faces is less affected by category-level (feature-based coding).  I also propose that category-level information is relatively less sensitive to effects of face inversion than individuated configural codes. The net result is that performance generally showed only small effects of inversion. The main exception to this result was for other-race, outgroup faces, which were recognised best when inverted. This is a surprising result. However, other-race, outgroup faces should be least subject to configural processing, while in the other conditions (e.g., for other-race, ingroup coding) configural coding should be weak. Weak configural codes, when inverted may be disruptive to recognition–an argument made in the literature on prosopagnosia (de Gelder et al., 1998; de Gelder & Rouw, 2000). In such cases, the benefit from face inversion has been attributed to patients extracting “noisy” (i.e., inefficient) configural representations from upright faces, which disrupts rather than facilitates recognition when faces are upright. Inverting the faces reduces configural coding, enabling the patients to improve. It may be, therefore, that other-race, outgroup faces are particularly robust to the effects of inversion.

## 6.2 Trait-Directed Encoding of Own-Race versus Other-Race Faces

In Experiments 4 and 6, participants’ recognition memory was tested after incidental learning, when their encoding task was to judge faces for likeability—a task more reminiscent of deep everyday face encoding. The results demonstrated that for own-race targets, ingroup/outgroup categorisation did not influence performance but it did affect recognition memory for other-race faces. This finding was replicated across the experiments. These data suggest that the default strategy of individuated processing held for all own-race faces, and that generalised to the processing of other-race faces assigned to the participant's own university. There was converging evidence for the default strategy being configural encoding, since all the faces showed strong inversion effects with the exception of the other-race outgroup stimuli. It may be that likeability judgements in particular emphasise configural processing for ingroup members regardless of whether they are categorised through visual (i.e., race) or non-visual dimensions (i.e., university group).

These findings are in stark contrast to the research on which the Categorisation–Individuation Model was based, where outgroup categorisation disrupted own-race processing (Hugenberg & Corneille, 2009) and recognition (Bernstein et al., 2007; Shriver et al., 2008). Hugenberg et al. (2010) explained these previous findings by arguing that individuation experience is only fully exploited to the extent that the motivation to individuate the target is engaged. In contrast, outgroup categorisation signals category rather than identity processing. In the current research, however, for own-race faces, either outgroup categorisation did not signal identity irrelevance or individuation experience was sufficiently strong that individuation motivation was irrelevant.

For other-race faces, interestingly, recognition sensitivity was no better for ingroup- than outgroup-categorised other-race faces, suggesting that a shift to greater configural processing does not support better representations of other-race faces. This, in line with the Categorisation–Individuation Model, the motivation to individuate is constrained by perceptual experience. Importantly, however, it is not the case that the motivation to individuate cannot induce a processing shift toward identity-diagnostic information but, rather, that this motivation is not sufficient, in the absence of perceptual experience, to result in strong recognition (in the case of other-race faces).

## 6.3 Recognition Memory Following Shallow Memory-Directed versus Deep Trait-Directed Encoding

These results demonstrate that incidental trait-directed encoding generated several shifts in performance relative to memory-directed intentional encoding. First, the detrimental effects of face inversion were stronger in Experiment 6 than in Experiment 5. I suggest that this is because intentional memory can be influenced by category-level coding of faces, which is less sensitive to inversion than configural coding (Experiment 5); in contrast deep, incidental encoding relies primarily on configural processing (Experiment 6). Second, the effects of ingroup categorisation were diminished for incidental memory for own-race faces. This suggests that de-fault face processing, is tuned to own-race faces. This form of processing also appeared to apply to other-race, own-university faces, suggesting that both social grouping and perceptual learning were effective in this circumstance. Third, there was stronger inversion effects in Experiment 6 than in Experiment 5 for all ingroup categorised faces, consistent with these faces being processed configurally.  To examine the role of intentional versus incidental learning more directly, I conducted an exploratory analysis using the combined data from Experiments 3 and 4. The analysis indicated that for *own-race* targets, outgroup categorisation impaired recognition among participants *with* an intentional memory goal; for *other-race* targets, in contrast, outgroup categorisation impaired recognition among participants *without* an intentional memory goal. This pattern seems to suggest that when perceivers actively attempt to remember faces, the motivation to individuate faces constrains individuation experience, but that, when perceivers process faces without memory-directed encoding, the direction of constraint is reversed—at least in the current experiments, where own-race and other-race faces were presented in an intermixed (i.e., inter-racial) context.

## 6.4 Criterion Bias and the Ingroup Overexclusion Effect

Although most investigations of the own-race effect do not report analyses of criterion/bias, these analyses were revealing of participants' behaviour because of ingroup/outgroup categorisation. In particular, I observed broad support for the "ingroup overexclusion effect" (Leyens & Yzerbyt, 1992; Yzerbyt, Leyens, & Bellour, 1995), at least in for racial ingroup/outgroup status. Across four experiments, participants adopted a more conservative criterion for own-race faces but a more liberal criterion for other-race faces, suggesting that participants were motivated to protect their racial identity.

There were also effects of non-racial (i.e., university) ingroup/outgroup status in Experiment 6, and Experiments 4 and 5 demonstrated an interaction between racial and non-racial ingroup/outgroup status. The pattern of these effects, however, was not consistent across experiments. Although it is not entirely clear from the extant literature *why* or *how* different cues to ingroup/outgroup status would interact, it is not surprising that university ingroup/outgroup status would exert influence less consistently than racial ingroup/outgroup status, simply because university status is a non-visual and thus less salient cue than race. It may be that participants have to work harder to process beyond racially salient cues to ingroup/outgroup membership. This suggests that cues to racial ingroup/outgroup status are more easily extracted than non-visually-salient university-based status. Whether non-racial ingroup/outgroup status would be more consistently influential in the absence of visually salient race cues is an empirical question for future research.

The distinction between incidental and intentional memory made in this chapter is not meant to imply that trait-directed encoding will always lead to processing that supports individuation or that memory-directed encoding will always lead to processing that supports categorisation. Indeed, there are cases in the literature of intentional memory instructions that effectively eliminate the other-race effect. Hugenberg, Miller, and Claypool (2007; see also Rhodes et al., 2009), for example, warned participants about the other-race effect and asked them to “do [their] best to try to pay close attention to what differentiates one particular face from another face of the same race, especially when that face is not of the same-race as you” (p. 337). Under these conditions, the other-race effect did not emerge.

Although Hugenberg et al. provided no data that speaks to the processing that was induced by their instructions; it is possible that the instructions led participants to rely more than usual on configural information in other-race faces. That is, intentional encoding may not always lead to greater reliance on featural than configural information; equally, incidental encoding may not always lead to greater reliance on configural than featural information. The important distinction is the relative reliance on configural versus featural information, not incidental versus intentional memory.

**6.5 Conclusion**

The current research demonstrates that ingroup/outgroup categorisation has different implications for own-race versus other-race face processing, and that these implications depend on the goal adopted by perceivers at encoding. When perceivers explicitly attempt to process faces to support later recognition, ingroup (versus outgroup) categorisation enhances subsequent recognition of own-race faces, but has no impact on recognition of other-race faces. In contrast, when perceivers’ process faces to make deeper, non-memory directed trait judgements, ingroup categorisation affects other-but not own-race recognition memory on a subsequent surprise test.

The current research demonstrates that ingroup/outgroup categorisation has different implications for own-race versus other-race face processing, and that these implications depend upon the goals at encoding (with own-race and ingroup faces prompting greater reliance on configural processing, relative to other-race and outgroup faces) and encoding goal (whether faces are coded intentionally for later memory [when category-level information can impact], or incidentally but at a deep level [when individuation based on configural coding is emphasised]). The findings provide evidence for a complex interaction of experience and motivation in own-race and other-race face processing, and underscore the importance of perceivers' encoding goals in shaping their processing strategies.

# CHAPTER 4

# ELECTROPHYSIOLOGICAL CORRELATES OF OWN- AND OTHER-RACE FACE PROCESSING AS A FUNCTION OF INGROUP/OUTGROUP CATEGORISATION [12]

*The current chapter examined the electrophysiological correlates of ingroup/outgroup categorisation and own- and other-race face processing. In Experiment 7, White participants performed a sequential matching task on pairs of upright and inverted faces that were either of their own race (White) or another race (Black) and labelled as being affiliated with the their own university or another university. Analysis of the behavioural data demonstrated a trend whereby for own-race faces, inversion costs were equivalent for own- and other-university targets; but for other-race faces, inversion costs were larger for own- than other-university targets, replicating previous results (Chapter 2, Experiment 1). Analysis of the face-specific N170 component of the ERP waveform demonstrated that for own-race faces, inverted-face processing was delayed relative to upright-face processing regardless of university ingroup/outgroup membership. For other-race faces, however, the inversion effect on the N170 was reliable only for own-university faces. Effects for race and university status did not emerge on the earlier P100 component, however, and effects for university status were no longer apparent on the later P200 component. This experiment provides evidence for the early interaction between perceptual experience and social categorisation processes in the structural encoding of own- and other-race faces, and clarifies recent and past models of face perception described in chapter 1.*

[12] Experiment 7 is reported in Cassidy, K. D., Boutsen, L., Humphreys, G. W., & Quinn, K. A. (in preparation). *Ingroup categorisation affects the structural encoding of other-race faces: Evidence from the N170 event-related potential.*

# 1 Introduction

The Categorisation–Individuation Model (Hugenberg et al., 2010) proposes that the other-race effect derives from the tendency to attend to identity-diagnostic information in own-race faces but to category-diagnostic information in other-race faces. Consistent with evidence that own-race faces are processed more configurally than other-race faces (i.e., in terms of spatial relationships between features; e.g., Rhodes et al., 1989; or more as a perceptual "whole" or gestalt; e.g., Michel et. al., 2006), the model asserts that the other-race effect derives from the tendency to attend selectively to identity-diagnostic information in own-race faces but to category-diagnostic featural information (e.g., skin tone) in other-race faces, and has its roots in both perceptual experience and motivated processing. In support of the model, Bernstein et al. (2007) demonstrated that when participants are directed to remember faces at encoding, outgroup (versus ingroup) categorisation undermines later recognition of own-race faces. Moreover, Hugenberg and Corneille (2009) demonstrated that outgroup (versus ingroup) categorisation reduces configural processing of own-race faces.

My own research (Cassidy et al., 2011; Chapter 2, Experiment 1) has also examined the interaction of perceptual experience and social categorisation. I asked White participants to perform a simultaneous matching task on upright and inverted faces (i.e., faces rotated by 180°) that were either own-race (White) or other-race (Black), and from their own university or another university. For other-race faces, participants demonstrated greater configural processing following own- than other-university labelling, as indexed by larger face-inversion costs (i.e., slower or less accurate responding to inverted than upright faces; Yin, 1969). In contrast, own-race faces showed strong configural processing irrespective of university labelling. I have observed the same pattern on recognition memory when participants were directed to make target likeability judgements at encoding, using inversion costs (Chapter 3, Experiment 6). I interpret this pattern of affect as reflecting the mutual constraint of experience and motivation: Ingroup categorisation of faces along non-racial dimensions motivates perceivers to engage in configural processing, regardless of race. In contrast, outgroup categorisation undermines motivation and allows different default strategies (with a greater emphasis on configural information for own-race faces and featural information for other-race faces) to drive processing (e.g., Cassidy et al., 2011; Hancock & Rhodes, 2008; Rhodes et al., 1989).

The above research has relied on purely behavioural measures (response times, error rates), which reflect the *outcomes* of face processing. Such measures may be limited in their ability to corroborate theoretical models such as the Categorisation-Individuation Model, which assumes the operation of intermediate processing stages that occur on a finer-grained time scale. In the current chapter, I turned to event-related potentials (ERPs), which support the chronometric assessment and functional characterisation of different stages of face perception (Bentin, Allison, Puce, Perez, & McCarthy, 1996; Rugg & Coles, 1995). Indeed, ERP studies of face perception have been able to relate distinct stages to ERP components, and to assess their sensitivity to perceptual and derived characteristics from faces (for a review, see Schweinberger, 2011).

Examining the electrophysiological correlates of own- and other-race face processing provides an opportunity to refine the Categorisation-Individuation Model. In its current form, the model is underspecified with regard to when or how non-racial ingroup/outgroup categorisation exerts its effects. In proposing that ingroup (versus outgroup) categorisation motivates individuals to reallocate selective attention toward identity-diagnostic facial characteristics and away from category-diagnostic facial characteristics, the model does not specify precisely what these facial "characteristics" are. That is, the model acknowledges the importance of configural information, but also leaves open the potential importance of different featural information in own-and other-race faces. Given that identity-diagnostic *characteristics* are not defined by Hugenberg et al., it is worth exploring the electrophysiological correlates of featural versus configural analysis in the context of own- and other-race face processing.

Such an approach may also be informative to more general models of face perception. The two most influential models of face processing are Bruce and Young's (1986) functional model and Haxby, Hoffman, and Gobbini's (2000, 2002) distributed neural model. Both models assume that face perception begins with perceptual analysis of features and structural encoding of the face, but they differ in their assumptions about post-structural encoding processes. Bruce and Young's model posits separate *and independent* operations to support the processing of idiosyncratic versus generic aspects of faces, whereas Haxby et al.'s model posits separate *but interactive* regions for the analysis of changeable versus invariant aspects of faces.

Germane to the current chapter, neither model addresses how extra-facial (i.e., perceiver and context) factors influence face processing (Quinn & Macrae, 2011). In our own research (Cassidy et al., 2011) and the research of Hugenberg and colleagues (e.g., Bernstein et al., 2007; Hugenberg & Corneille, 2009), non-visually-accessible ingroup/outgroup categorisation cues at encoding have been shown to shape perceptual differentiation and subsequent recognition. Whether these cues influence perceptual analysis, structural encoding, or later processing is not clear from the outcome-focused data, but it is also the case that neither the Bruce–Young (1986) functional model nor Haxby et al.'s (2000, 2002) distributed neural model can be used to generate predictions about the locus of these effects.

## 1.1 Electrophysiological Correlates of Face Processing

Electrophysiological studies have demonstrated several components that are implicated in face processing, ranging in a time window between approximately 90 and 200 ms after face onset (for a review see Schweinberger, 2011)[13].

***1.1.1 P100: Face detection and pictorial encoding.*** The P100 is a positive deflection that occurs around 80–100 ms post stimulus onset over medial occipital sites (Woodman, 2010). The P100 tends to be a domain-general component that is sensitive to low-level visual transformations, such as visual changes in luminance and contrast polarity (Halgren, Raji, Marinkovi, Jousmaki, & Hari, 2000; Itier & Taylor, 2002; Rebai, Poiroux, Bernard & Lalonde, 2001; Rossion, Joyce, Cottrell, & Tarr, 2003).

Although the P100 has been demonstrated to be larger for faces than control stimuli, such as scrambled faces (Herrmann, Ehlis, Ellgring, & Fallgatter, 2005), other research suggests that it is far less consistently modulated by face/object categories (Itier & Taylor, 2004), with some studies finding no specificity at all (e.g., Boutsen, Humphreys, Praamstra, & Warbrick, 2006; Rossion et al., 2003). Elsewhere, the P100 has been found to be modulated by top-down attentional processes in face perception (Rutman, Clapp, Chadick, & Gazzaley, 2009). Therefore, although this component is far from fully understood, it is likely that the P100 may reflect may reflect an earlier pictorial encoding stage of face perception (Desjardins & Sagalwitz, 2009; Schweinberger, 2011; but see Hahn, Jantzen & Symons, 2012, for evidence of early "configural" processing), such that a whole-face "percept" is not available to the perceiver at this stage (Rossion & Caharal, 2011).

[13] There are several other components not included in this review: for example the N250, and the N400. The N250 is larger for familiar than unfamiliar faces (e.g., Schweinberger et al., 1995, Tanaka & Pierce, 2009). The N400 is not a processing stage per se, but modulates the semantic information about the face (i.e., for example names and familiar faces evoke a similar N400; Schweinberger, 1996). As I was interested more in how group categorisation informed perceptual processing, and because the faces were all unfamiliar faces (i.e., taken from face databases) these components are not reviewed here.

***1.1.2 N170: Structural encoding of faces.*** The N170, occurring around 70ms post-stimulus onset, is a negative deflection that appears bilaterally (though often favouring the right hemisphere, over occipito-temporal sites (Bentin et al., 1996; Rossion et al., 1999). The N170 has been identified as an integral early marker of face processing (e.g., Bentin et al., 1996), as it shows face sensitivity in that its peak amplitude is larger in response to face-like compared to non-face-like stimuli. The N170 is modulated by photographs of faces and line drawings (e.g., Bentin et al., 1996; Sagiv & Bentin, 2001); Mooney faces (George, Jemel, Fiori, Chaby, & Renault, 2005); suggesting that the N170 is associated mainly with face processing rather than general visual processing. The N170 is generally thought to reflect the later stages of structural encoding (e.g., Bentin et al., 1996; Eimer, 2000a, b, c), and has been shown to be sensitive to configural information in faces (e.g., Boutsen et al., 2006; Liu et al., 2002; Vizioli et al., 2010), using various manipulations of configural processing including the Thatcher-illusion (Boutsen et al., 2006; Carbon, Schweinberger, Kaufmann, & Leder, 2005; Hahn et al., 2012) as well as face inversion; such that inverted faces yield larger and/or delayed N170s relative to upright faces (e.g., Eimer, 2000b; Itier & Taylor, 2002). Given that inversion and the Thatcher illusion are known to disrupt face recognition and configural processing (Maurer, Le Grand, & Mondloch, 2002), the susceptibility of the N170 to inversion effects underscores its role in configural face encoding. Its role as a neural marker of specific *perceptual* processes is further underlined by the observation that the N170 is not modulated by purportedly higher-order derived information such as face familiarity (Bentin & Deouell, 2000; Eimer, 2000b), identity (Gosling & Eimer, 2011), or emotional expression valence (Bobes, Martin, Olivares, & Valdes-Sosa, 2000; Eimer & Holmes, 2002, 2007).

***1.1.3 P200 Group Processes.*** Occurring approximately 30 ms later is the P200, a positive deflection that has been demonstrated to index higher-order perceptual processing and to be modulated by attention. It has been demonstrated to be sensitive to face categorization and attention-based processes (e.g., Dicketer & Bartholow, 2007; Ito & Bartholow, 2009; Kuboto & Ito, 2007; Willadsen-Jensen & Ito, 2006), although the component remains far from fully understood (Woodman, 2010).

**1.1.4 ERP components responsive to race.** Of critical importance, the P100, N170 and P200 all show latency and/or magnitude differences for own- versus other-race faces. For example, the P100 has been demonstrated to be larger for other-race than own-race faces (e.g., Herrmann et al., 2007). However, it has been argued that such differences may be a consequence of lower-level visual information differences in stimuli (e.g., Vizioli et al., 2010, see also Rossion & Caharel, 2011), perhaps reflecting differences in lower-level visual information than race categorisation per se.

The N170 is also sensitive to race (Caldara et al., 2003; Gajewski, Schlegel, Stoerig, 2008; Ito & Urland, 2003, 2005; Stahl, Wiese, & Schweinberger, 2008, 2010; Vizioli, et al., 2010; Weise, Stahl, & Schweinberger, 2009). Ito and Urland (2003), for example, asked participants to categorise Black and White target faces on the basis of gender or race while recording participants' ERPs. Ito and Urland found that the N170 amplitude was larger for other-race than own-race faces, regardless of whether the participants were explicitly attending to race or gender (Experiment 1); this difference was maintained when faces were equated for colour information (Experiment 2). Ito and Urland suggest that their data constitute evidence that greater amounts of attention are directed to other-race relative to own-race faces, and that racial category information is automatically encoded and orientated towards (Ito & Urland, 2008; see also Kubota & Ito, 2007; Stahl et al., 2008; Walker, Silvert, Hewstone, & Nobre, 2008).

More recently, Vizioli et al. (2010) recorded the ERPs of participants whose task was to indicate whether upright and inverted Black and White faces were framed by a red or green border. Vizioli et al. observed that the race of stimuli modulated the magnitude of the face inversion effect at N170, such that inversion was more detrimental for own-race than other-race faces. This pattern is consistent with behavioural accounts of the face inversion effect (e.g., Hancock et al., 2008; Rhodes et al., 1989; Sangrigoli & de Schonen, 2004), and supports a link between configural processing and structural encoding of faces.

The P200 has also been observed to be modulated by race (e.g., Caldara, Rossion, Bovet, & Hauret, 2004), such that the P200 is larger and more delayed for other-race faces (e.g., Dicketer, & Bartholow, 2007; Ito & Bartholow, 2009; Kuboto & Ito, 2007; Willadsen-Jensen & Ito, 2006). Modulation of the P200 by race has been argued to reflect processes related to active categorisation of visual stimuli (e.g., Ito & Bartholow, 2009; Latinus & Taylor, 2005).

In summary, although there is some inconsistency across all studies for the P100, N170 and P200, with race effects sometimes emerging and sometimes not, the general pattern is for delayed and/or enhanced ERP components for other- versus own-race faces. Thus, all of these components are candidates for the ingroup/outgroup categorization effects proposed in the Categorization–Individuation Model.

## 2 Experiment 7

In Experiment 7, I analysed the ERPs to investigate whether the ingroup/outgroup categorisation effects observed in Experiment 1 would also emerge at the electrophysiological level. White participants who performed a sequential matching task on White (own-race) and Black (other-race) face pairs that were labeled as students from either the same or another university. Specifically, they indicated whether the second (test) face was identical to the first (study) face. I analysed EEG activity in response to test faces as a means of investigating the neural correlates of ingroup/outgroup categorisation effects. I focused on test faces only, because I reasoned that participants would process study faces with the goal of being able to remember them. My focus in this chapter, instead, is to investigate non-memory-directed face processing.

Because the N170 is susceptible to inversion effects (e.g., Eimer, 2000b; Itier & Taylor, 2002) and is linked to the structural encoding that would show evidence of disrupted/delayed configural processing (Bentin et al., 1996; Eimer, 2000a, b, c), and given that inversion effects have been shown to be larger for own-race than other-race faces (e.g., Rhodes et al., 1989), I predicted that the ingroup/outgroup categorisation effects that I have observed previously (e.g., Chapter 2; Cassidy et al., 2011) would be reflected in the N170. Based on my previous behavioral data in Experiment 1, I predicted that for own-race faces, configural processing should be engaged equally for ingroup and outgroup faces; as a result, the N170 component should be delayed for inverted versus upright faces for both ingroup and outgroup own-race faces. For other-race faces, however, configural processing should be engaged to a greater extent for ingroup than outgroup targets; in this case, there should be a delay in the N170 component for inverted versus upright other-race faces only for faces categorised as ingroup members.

Whether the P100 or P200 would show similar effects was less clear, given their less consistent relationship to own- and other-race status and inversion effects. Assuming ingroup/outgroup categorisation would influence the N170, however, measuring the extent to which ingroup/outgroup categorisation would also influence the components chronologically preceding (P100) and succeeding (P200) this target component may provide insight into the nature of this influence—for example, whether ingroup/outgroup categorisation effects would be tied to face processing per se or would generalize to non-face-specific (but nonetheless relevant) processes.

## 2.1 Method

**2.1.1 Participants and design.** Sixteen White undergraduate students from the University of Birmingham (15 female, $M_{age}$ = 19.8 years) participated in exchange for partial course credit. All reported normal or corrected-to-normal vision. The experiment was based on a 2 (target race: own-race, other-race) × 2 (target university: own-university, other-university) × 2 (orientation: upright, inverted) × 2 (trial type: same, different match) within-participants design.

**2.1.2 Materials.** Materials were the same as in Experiments 3–5. The face stimuli were grouped into 160 unique same-race, same-orientation pairs, with an effort to match paired stimuli along a variety of dimensions (e.g., luminance, contrast, head/hair shape). The pairs were divided into sets such that each participant received a different set, each face appeared as an own-university target for some participants but as an other-university target for others, and each face appeared on a "same" trial for some participants but on a "different" trial for others. Each face pair appeared twice per set (once upright and once inverted).

**2.1.3 Procedure.** Prior to the EEG experiment, participants completed the same group identification questionnaire as in previous experiments. Following preparation for the EEG recording, each participant was instructed in the sequential face-matching task. Participants learned they would see faces of students from the University of Birmingham or the University of Nottingham, as indicated by the university's respective logo and name at the start of each trial. Participants learned further that two faces would then be presented sequentially, and that their task was to indicate as quickly and as accurately as possible whether the second (test) face had the same identity as the first (study) face.

Stimulus presentation, interfaced with the EEG system, and response collection were controlled by purpose-written programs built using *E-Prime 2.0 Professional* (Psychology Software Tools, 2009). Stimuli were viewed from a distance of approximately 80 cm and were presented on a 15-in. CRT screen in a 1024 × 768 graphics mode (with a vertical refresh rate of 60 Hz) and driven by a Pentium PC running an ATI RAGE PRO 128-MB graphics card. Each trial sequence contained the following centrally presented events (see Figure 11): fixation cross (300 ms), group prime (1500 ms), study face (500 ms), and test face (500 ms). To minimise preparatory activity in the EEG signal, the durations of the blank intervals between the group prime and the study face, and between the study and test faces, were independently randomised between 900, 1000, and 1100 ms. A valid response was accepted as soon as the test face appeared and was followed by an intertrial interval of 1500 ms. The 320 trials were presented in four blocks of 80 trials without feedback.

**2.1.4 EEG recording, offline processing, and component detection.** EEG was continuously recorded using 128 Ag/AgCl scalp electrodes, arranged according to the 10-5 electrode system (Oostenveld & Praamstra, 2001) using a nylon cap. Vertical and horizontal eye movements were monitored by two unipolar electrodes placed at the infraorbital area below each eye and at the outer canthus of the right eye. EEG and electro-oculogram (EOG) signals were amplified with a band-pass of 0–128 Hz by BioSemi Active-Two amplifiers (BioSemi, Amsterdam, Netherlands) and sampled at 512 Hz. The raw EEG was re-referenced to the average activity.

The EEG data for the individual trials were segmented offline using *BrainVision Analyzer v1.0* (Brain Products, Munich, Germany). Each segment was 800 ms long, starting 200 ms before the onset of the test face (which defined the baseline), and lasted for 600 ms after onset, respectively. All channels in all segments were manually inspected for oculomotor and noise artifacts. Segments corresponding to incorrect responses, RT outliers, or containing oculomotor artifacts (exceeding 100 µV) were excluded from the ERP analysis, as were channels with artifacts exceeding 150 µV. Finally, segments were band-pass filtered (0.5–30 Hz) and corrected to the 200-ms pre-stimulus baseline before averaging.

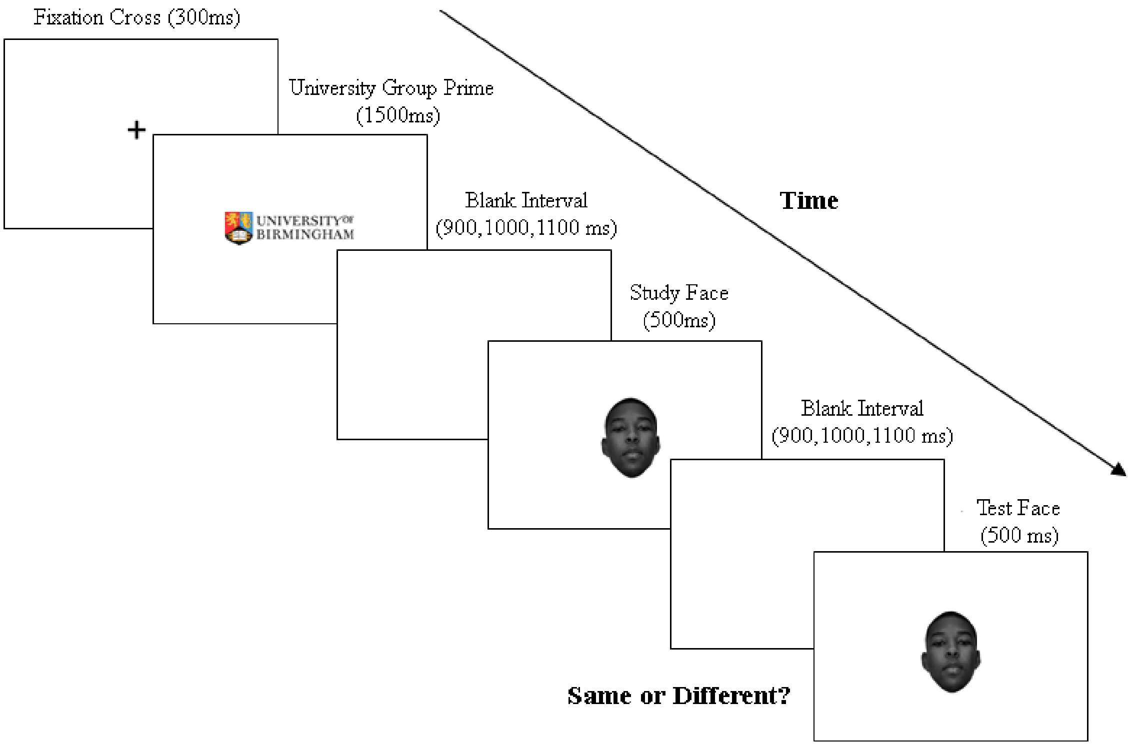


***Figure 11*. Example stimuli sequence, Experiment 7. Participants were presented with (i) either an own-university (University of Birmingham) or other-university (University of Nottingham) prime, (ii) a study face, and (iii) a test face, and then made same/different identity judgements. Faces were either own-race (White) or other-race (Black), and presented in either upright or inverted orientation.**

For each participant, segments corresponding to each Race × University × Orientation condition were averaged; the resulting means were then averaged over participants creating grand averaged ERP waveforms for each condition. Topographical current source density (CSD) maps of this activity were inspected to identify the scalp electrodes that represented the focus of the N170 component (see Figure 12). The average N170 activity for each participant in each condition was then determined by averaging from two pools of 7 electrodes each, in the left (P7, PO7, P9, PO9, POO9h, PPO9h, TPP9h) and right (P8, PO8, P10, PO10, POO10h, PPO10h, TPP10h) hemispheres (See Figure 12, for a spatial layout of the electrode pools). For each participant, the average peak amplitude within a 20-ms time window (centred on the peak) and the absolute peak latency (ms) from each pool in each condition were determined for each component of interest from the electrode pools in each condition.

## 2.2 Results

**2.2.1 Behavioural results.** The behavioural data (reaction times and error rates) were submitted to a Race × University × Orientation repeated-measures analysis of variance (ANOVA). The ANOVA summary tables are presented in Appendix BA.

***2.2.1.1 Reaction time (RT).*** RTs exceeding 2.5 standard deviations from the mean correct individual RT were excluded (3.49% of the data) alongside RTs from trials where errors were committed (4.08% of the data). The RT analysis revealed that participants responded faster to upright than inverted test faces (*M*s = 675 vs. 718 ms, respectively), $F(1, 15) = 31.25$, $p < .001$, $\eta_p^2 = .68$.

Although the predicted Race × University × Orientation interaction failed to reach significance, $F(1, 15) = 1.26$, $p = .28$, $\eta_p^2 = .07$, the pattern of means was as predicted (replicating Chapter 1, Experiment 1; see Table 6). For own-race faces, inversion was equally disruptive for own-university and other-university targets (inversion effect *Ms* = 50 and 46 ms, respectively); for other-race faces, inversion was more disruptive for own-university than other-university targets (inversion effect *M*s = 46 and 31 ms, respectively).

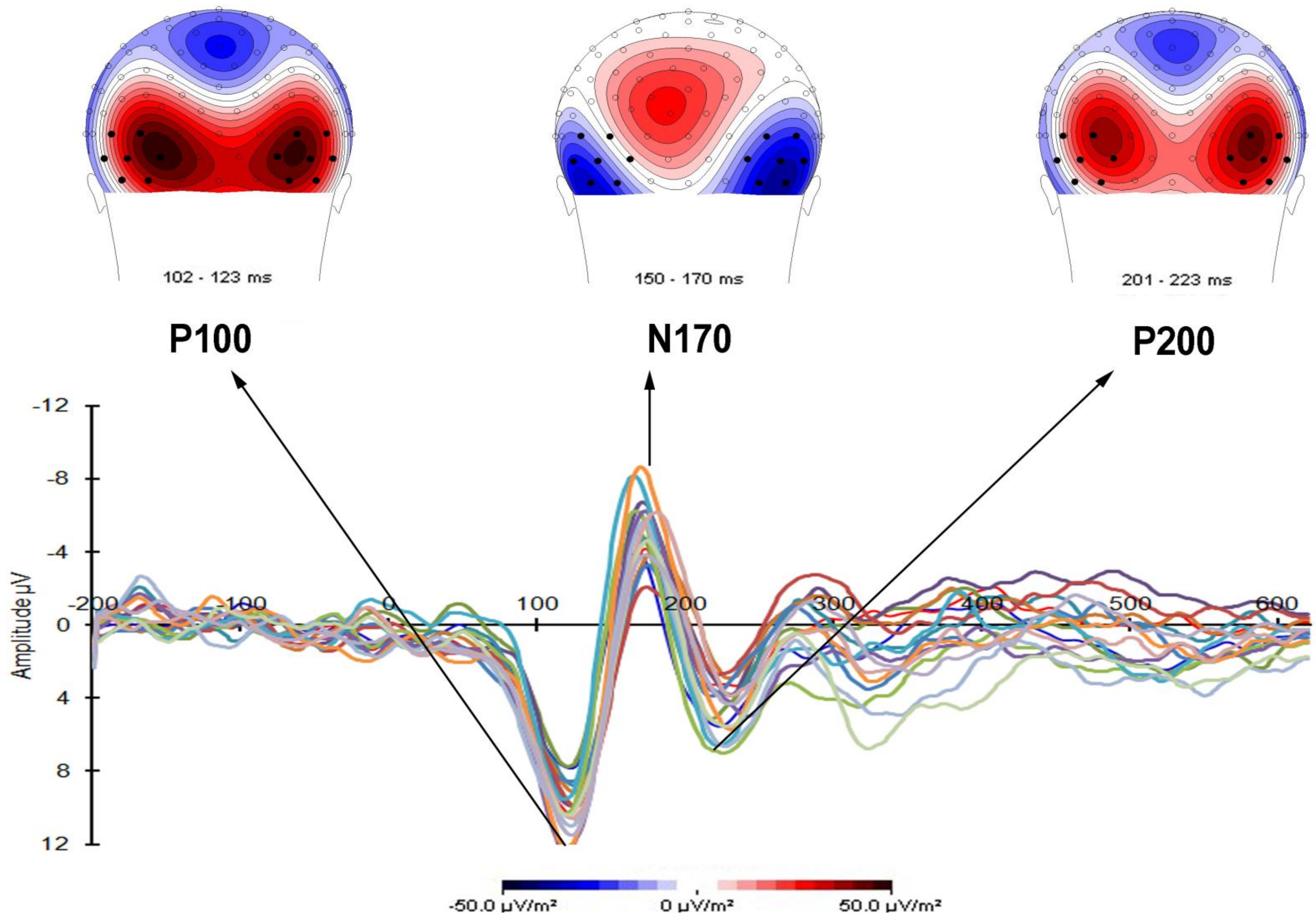


***Figure 12*. Test face grand-average ERP waveforms as a function of hemisphere, race, university and orientation, and P100, N170 and P200 CSD topographical maps. CSD maps show a 20 ms time window centred around the component of interest from electrode O1.**

***2.2.1.2 Error rates.*** The error rate analysis revealed that participants made fewer errors for own-race than other-race faces (*M*s = 0.20 vs. 0.27%, respectively), $F(1, 15) = 8.77$, $p = .010$, $\eta_p^2 = .37$. Participants were also less error-prone for upright than inverted faces (*M*s = 0.15 vs. 0.32%, respectively), $F(1, 15) = 29.86$, $p < .001$, $\eta_p^2 = .67$. No other effects approached significance, all *p*s > .56.

**Table 6**
***Mean reaction time (ms) to test faces as a function of race, university, and orientation, Experiment 7***

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | 664 (46.84) | 714 (50.54) | 668 (46.96) | 713 (49.34) |
| Other Race (Black) | 680 (47.51) | 726 (50.87) | 689 (47.26) | 720 (48.16) |

*Note*. Numbers in parentheses represent standard error.

**2.2.2 ERP results.** Grand-averaged P100, N170, and P200 latencies and peak amplitudes per condition from the selected electrode pools were analysed for test faces[14]. The data were initially submitted to a Race × University × Orientation × Hemisphere repeated-measures ANOVA. Grand average waveforms and current source density (CSD) topographical maps for the P100, N170, and P200 components are presented in Figure 12.

***2.2.2.1 P100.*** Condition means and ANOVA summary tables are presented in Appendix CA.

*2.2.2.1.1 Latency*. The analysis demonstrated no significant main effects or interactions ($p > .05$).

*2.2.2.1.2 Amplitude*. The analysis demonstrated a significant main effect of hemisphere; revealing that the P100 was larger over the right than the left hemisphere (*M*s =

[14] I also analysed ERPs for study faces. Generally the pattern of effect was similar to that demonstrated for intentional memory (Chapter 3, Experiment 3 & 5), in that ingroup categorisation delayed the P100 for own-relative to other-university faces, and the P100 was larger for own-university than other-university own-race faces. This is generally consistent with evidence suggesting that the P100 can be affected by top-down influences in visual attention (Rutman, et al., 2010).

11.32 vs. 9.50 µV, respectively). Consistent with previous research (e.g., Vizioli et al., 2010), there was also a main effect of target orientation, $F(1, 15) = 22.28$, $p < .001$, $\eta_p^2 = .72$, revealing that the P100 was larger for inverted than upright faces (*M*s = 11.13 vs. 9.68, µV, respectively). There were no main or interaction effects involving university, all $F < 1.93$, all *p*s > .18.

***2.2.2.2 N170.*** Condition means and ANOVA summary tables are presented in Appendix DA.

*2.2.2.2.1 Latency*. The analysis revealed main effects of race and orientation. Consistent with past research (e.g., Stahl, Wiese, & Schweinberger, 2008, 2010; Weise, Stahl, & Schweinberger, 2009), the N170 peaked later for other-race than for own-race faces (*M*s = 166 vs. 159 ms, respectively), $F(1, 15) = 38.25$, $p < .001$, $\eta_p^2 = .72$. Also consistent with past research (e.g., Rossion et al., 1999, Weise et al., 2009; Vizioli et al., 2010), it also peaked later for inverted relative to upright faces (*M*s = 166 vs. 160 ms, respectively), $F(1, 15) = 18.67$, $p = .001$, $\eta_p^2 = .55$. There was no main effect of university, $F(1, 15) = 0.26$, $p = .61$, $\eta_p^2 = .02$; however, university did interact with orientation, $F(1, 15) = 5.02$, $p = .040$, $\eta_p^2 = .25$. As predicted, this effect was subsumed within a reliable Race × University × Orientation interaction, $F(1, 15) = 5.96$, $p = .028$, $\eta_p^2 = .28$ (see Figure 13, Panel B).

To examine this interaction in more detail, I conducted separate University × Orientation ANOVAs for each target race. For own-race faces, the N170 peak latency reliably delayed for inverted relative to upright faces, $F(1, 15) = 18.96$, $p = .001$, $\eta_p^2 = .56$; no further effects were observed (all *p*s > .58). For other-race faces, orientation interacted with university, $F(1, 15) = 10.25$, $p = .006$, $\eta_p^2 = .40$. For own-university targets, the N170 component was delayed for inverted relative to upright faces (*M*s = 171 vs. 163 ms, respectively; $t(15) = 4.16$, $p = .001$, $d = .87$); there was no inversion cost for other-university targets (*M*s = 167 vs. 166 ms, respectively; *t*(15) = 0.10, *p* = .92, *d* = .02

*2.2.2.2.2 Amplitude.* The analysis revealed main effects of race and hemisphere. Consistent with past research (e.g., Stahl et al., 2008; Vizioli et al., 2010), the N170 amplitude was larger for own-race than for other-race faces (*M*s = -6.40 vs. -4.80 µV, respectively), *F*(1, 15) = 7.58, *p* = .015, $n_p^2$ = .34. It was also larger over the right than the left hemisphere (*M*s = -6.49 vs. -4.70 µV, respectively), *F*(1, 15) = 5.20, *p* = .038, $\eta_p^2$ = .26. A Race × Hemisphere interaction, *F*(1,15) = 6.77, *p* = .020, $\eta_p^2$ = .30, indicated that the amplitude difference between own- and other-race faces was larger over the right than the left hemisphere (right, *t*(15) = 3.15, *p* = .007, *d* =.39; left, *t*(15) = 1.97, *p* = .068, *d* = .13).

There was no main effect of university, *F*(1, 15) = 0.48, *p* = .49, $\eta_p^2$ = .03; however, university did interact with race, *F*(1, 15) = 6.63, *p* = .021, $\eta_p^2$ = .31 (see Figure 14). Own-race faces elicited a larger N170 amplitude when preceded by other-university rather than own-university primes (*Ms* = -7.34 and -5.44 µV, respectively), *t*(15) = 2.35, *p* = .033, *d* = .35 whereas other-race faces showed a marginally larger amplitude after own-university than other-university primes (*Ms* = -5.47 vs. -4.11 µV, respectively), *t*(15) = 2.00, *p* = .064, *d* = .32.

***2.2.2.3 P200.*** Condition means and ANOVA summary tables are presented in Appendix EA.

*2.2.2.3.1 Latency.* The analysis demonstrated a significant main effect of hemisphere, *F* (1, 15) = 5.87, *p* = .028, $\eta_p^2$ = .28, revealing that the P200 peaked later over the right than the left hemisphere (*M*s = 219 vs. 216 ms, respectively). There was also a main effect of target race, *F*(1, 15) = 7.07, *p* = .018, $\eta_p^2$ = .18, revealing that the P200 was delayed for other-race relative to own-race faces (*M*s = 220 vs. 215 ms, respectively).

*2.2.2.3.2 Amplitude.* The analysis demonstrated a significant main effect of hemisphere, $F(1, 15) = 6.88$, $p = .019$, $\eta_p^2 = .32$, revealing that the P200 was larger over the right than the left hemisphere (*M*s = 6.46 vs. 4.82 µV, respectively). There was also a main effect of target orientation, $F(1, 15) = 5.45$, $p = .034$, $\eta_p^2 = .27$, revealing that the P200 was larger for upright than inverted targets (*M*s = 6.55 and 4.73 µV, respectively). Finally, there was a marginally significant main effect of target race, $F(1, 15) = 4.04$, $p = .063$ , $\eta_p^2 = 21$, revealing the P200 was larger for own-race than other-race faces (*M*s = 6.19 and 5.08, respectively)[15].

**2.3 Discussion**

Experiment 7 examined the electrophysiological correlates of ingroup/outgroup categorisation in the context of own- and other-race face processing. I observed no reliable main or interaction effects involving target university for the P100 or P200; instead the results suggested that non-racial categorisation exerts its effect specifically within the N170 time window. In particular, the analysis uncovered a Race × University × Orientation interaction on the latency of the N170 component of the ERP waveform, a negative deflection that has been assumed to reflect face-specific processing (e.g., Bentin et al., 1996; Eimer, 2000b). For own-race faces, the processing of inverted faces was delayed relative to the processing of upright faces, regardless of non-racial ingroup/outgroup status. For other-race faces, inversion also delayed processing—but only in the case of own-university faces.

[15] I also analysed responses to the N250 component of the ERP. Although there is some evidence that familiarity and race can modulate the N250 (e.g., Tanaka & Peirce, 2009, Hermann et al., 2007), I observed no such effects, only finding a main effect of orientation for the N250 amplitude, and no effects for latency.

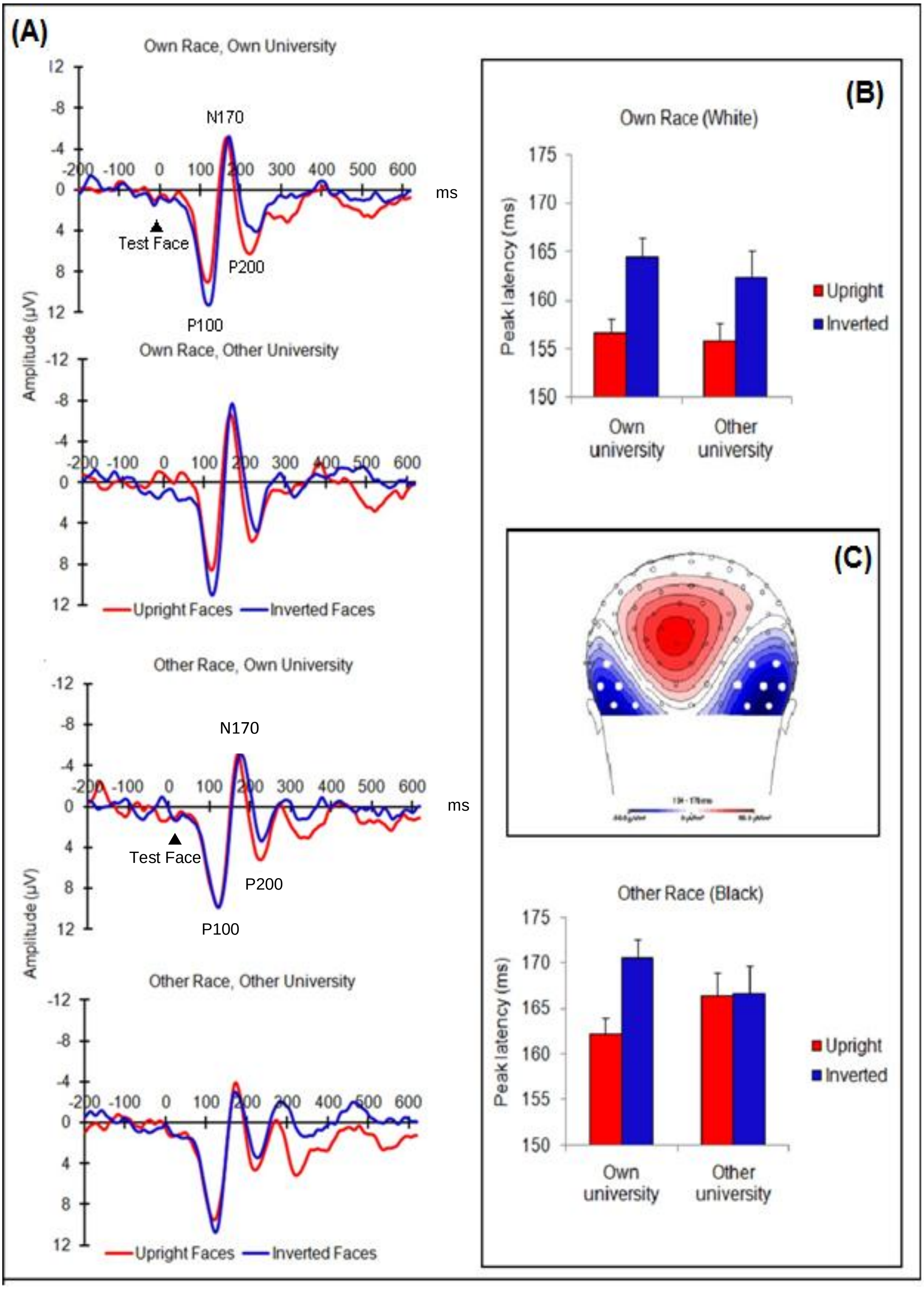


***Figure 13*** **.Group average pooled ERP waveforms (Panel A) and N170 peak latencies (Panel B, *M* ± *SEM*) to test faces as a function of race, university, and orientation. *Note.* Error bars denote standard error. ERP activity was pooled from left and right occipital-temporal electrode locations (shown in Panel C, which also illustrates the topographical distribution of N170 current source density at a typical peak latency window (line spacing: 10 µV/m$^2$)).**

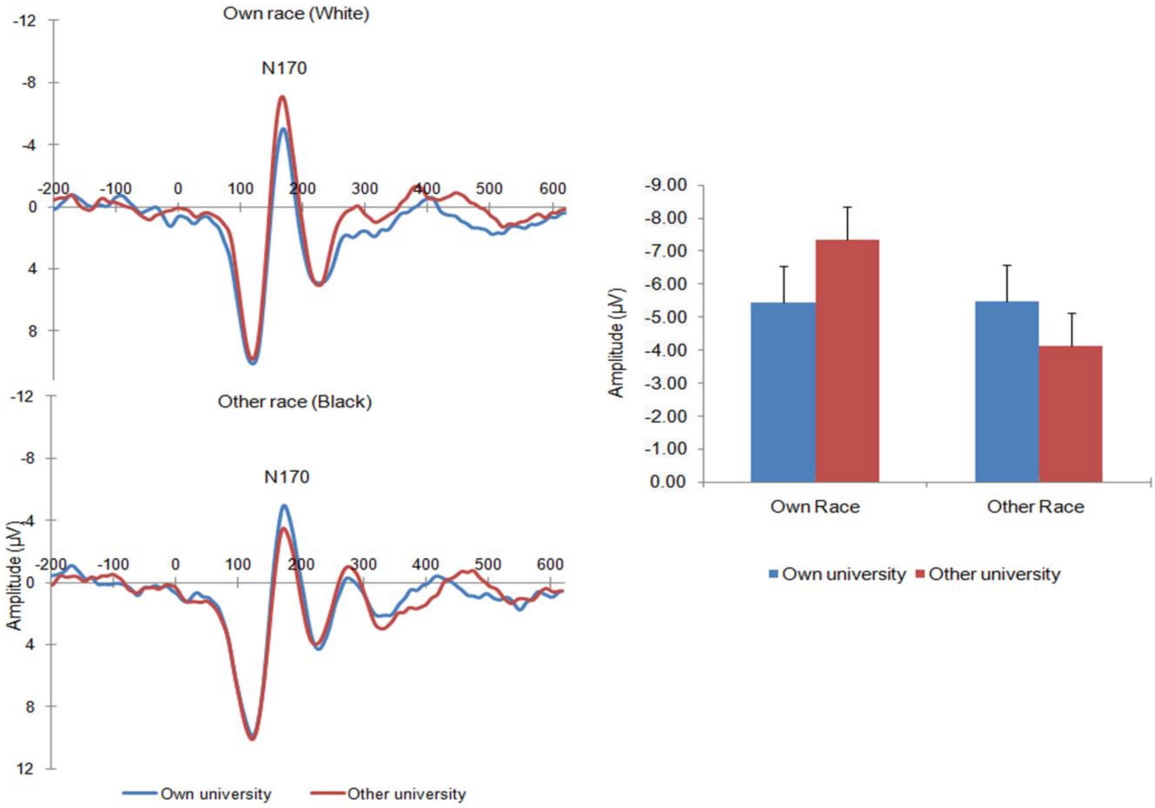


***Figure 14.*** **ERP waveforms and N170 amplitude graph (M ± SEM) as a function of race and university, Experiment 7.** *Note.* Error bars denote standard error.

This pattern of results, with effects of inversion emerging for other-race faces only when they were categorised as ingroup members, is consistent with the previous behavioural findings for perceptual discrimination (Cassidy et al., 2011; Chapter 2, Experiment 1) and incidental recognition (Chapter 3, Experiment 6). I have interpreted this pattern as reflecting the interaction of current motivation and perceptual experience: For own-race faces—a highly familiar class of stimuli—any motivation *not* to process outgroup faces as extensively as ingroup faces, induced by university categorisation, was insufficient to override the dominant configural processing strategy used; hence, effects of inversion emerged. For other-race faces, however, the data indicate that the categorisation-induced motivation to process ingroup faces more extensively than outgroup faces led to ingroup faces being processed configurally, whereas there was no evidence for this with outgroup other-race faces (i.e., no effect of inversion on behaviour or ERPs). It is striking that the effects of motivation-based categorisation arose as early as the N170 component, typically taken to reflect the structural encoding of faces (Eimer, 2000b).

The results for N170 amplitudes differed. As previously noted, the N170 amplitude was larger for own- than for other-race faces. However, this effect interacted with how the faces were categorised. For own-race faces, outgroup categorisation increased the N170 amplitude. In contrast, for other-race faces, outgroup categorisation decreased the N170 amplitude. It may be that the disparity between ingroup status on the racial dimension and outgroup status on the university dimension led to more attention to own-race outgroup members whereas, for other-race faces, the indication of outgroup status on both racial and university dimensions led to reduced attention and lower N170 amplitudes. Critically, however, these general effects did not interact with inversion, which affected N170 latencies to reflect the interaction between current motivation and default processing strategies (to own- and other-race faces).

**2.3.1 Effects earlier/later than structural encoding.** Although the focus of Experiment 7 was on structural encoding, as indexed by the N170, I also explored earlier and later components of face perception known to be sensitive to target race. I found no evidence for differential P100 components as a function of target race or university. The lack of finding with regard to race is surprising, given that other have reported that the P100 responds to race (e.g., Hehman et al., 2011). Importantly, however, and consistent with previous research (e.g., Vizioli et al., 2010), there was an effect of target orientation, indicating that the P100 amplitude was larger for inverted relative to upright targets. This effect is consistent with the literature suggesting that the P100 captures feature-based information (e.g., Liu, Harris, & Kanwisher, 2002).

Following structural encoding indexed by the N170, I found that the P200 was delayed and marginally smaller for other-race than own-race faces. This is consistent with results presented elsewhere that suggest that the P200 component indexes information related to categories such as race (e.g., Caldara et al., 2004). Interestingly, this component failed to be modulated by university ingroup/outgroup status. This suggests that visually salient information is indexed more efficiently by the P200 than non-visually-salient information, such as non-racial group membership.

**2.3.2 Relation to past literature.** The separate contributions of categorisation-induced motivation and default processing strategies are to some extent supported by recent evidence from Hehman, Stanley, Gaertner, and Simons (2011). Using a similar Race × University design, their behavioural results showed that there was equivalent recognition of own- and other-university faces belonging to the same racial group as the participants, but better recognition of own- than other-university faces belonging to another racial group. This is the same pattern as I observed (see also Chapter 3, Experiment 4). Hehman et al. also examined ERPs, reporting data on peak amplitudes of the P100 and N200 components. They reported main effects of race and university-group categorisation, not the interaction I observed on amplitudes for the N170. Both results indicate that categorisation of individuals as belonging to the same university group can affect early components of the ERP response. In our case, the increased amplitude for outgroup-categorised own-race faces suggests that university categorisation can magnify attentional biases. Over and above this, though, the N170 latency data indicate that university categorisation can induce early qualitative differences in structural encoding of faces.

It is important to note that, in the current experiment, race and university affiliation represented different types of ingroup/outgroup information. Race was a visually accessible facial cue, whereas university affiliation was a verbal label that was associated only arbitrarily with the faces. Interestingly, the Categorisation–Individuation Model (Hugenberg et al., 2010) is agnostic on the question of whether visually accessible versus non-accessible ingroup/outgroup categorisation should be accorded differential status. Although both forms of ingroup/outgroup categorisation exerted their effects at the same processing stage in the current experiment (i.e., the N170), the visually accessible race dimension demonstrated a longer-lived impact, modulating both the N170 and P200; in contrast, the non-visual university dimension modulated only the N170. This pattern alludes to the possibility that not all forms of ingroup/outgroup status have equal weight in processing. Admittedly, our manipulation of non-racial ingroup/outgroup categorisation may have had little emotional impact on participants and, in real-world settings, salient or important non-racial identities may be less prone to decaying activation. The relative impact of racial and non-racial categorisation on face processing thus remains to be clarified.

By targeting extra-facial factors, our findings also speak to more general models of face processing. The Bruce–Young (1986) functional model, at least in its original form, does not allow feedback from activated representations in the "cognitive system" to structural encoding; instead, the impact of the cognitive system's contents are restricted to direct visual analysis (e.g., of expression, speech). Our N170 findings, however, provide clear evidence that at least one extra-facial factor—ingroup/outgroup categorisation—does influence structural encoding. The same criticism cannot be made of Haxby and colleagues' (2000, 2002) functional model, which does allow for feedback between the core and extended systems. Given that both the P100 and N170 have been localized to fusiform gyrus (Hermann et al., 2005; Itier & Taylor, 2004), however, our findings are interesting in that they highlight the need to distinguish between the representation of invariant aspects of faces and identity recognition, as in Haxby et al.'s model.

**2.3.3 Caveat.** The behavioural Race × University × Orientation interaction was not statistically reliable. Nonetheless, the pattern of means was as predicted, and replicated Experiment 1. Given the small sample size in the current experiment relative to our past research, the lack of statistical reliability most likely reflects lower power and thus should pose no cause for concern.

## 2.4 Conclusion

The current chapter demonstrates that ingroup/outgroup categorisation has different effects on the processing of own- versus other-race faces, and that these effects emerge early in visual processing, at the stage of structural encoding. Ingroup (versus outgroup) categorisation prompts more configural processing of other-race faces, but has no impact on the configural processing of own-race faces. These patterns reflect shifts in processing strategy as a function of racial and non-racial ingroup/outgroup status (with own-race and ingroup faces prompting greater reliance on configural processing, relative to other-race and outgroup faces) and highlight the importance of considering both experience and motivation in own-race and other-race face processing.

# CHAPTER 5:

# HOLISTIC PROCESSING OF OWN-AND OTHER-RACE FACES AS A FUNCTION OF INGROUP/OUTGROUP CATEGORISATION[16]

*The experiments reported thus far used face-inversion effects as a marker of configural processing, to understand how ingroup/outgroup categorisation affects the processing of own- and other-race faces. Whether face inversion actually disrupts configural processing or merely delays it, however, is a matter of debate. In the final experiment of this thesis, I investigated whether the effects of face inversion on own- and other-race face processing would replicate with a manipulation purported to affect a related form of processing, namely, holistic processing. White participants performed a same/different matching task with face composites that were either own-race or other-race, labelled as being from their own university or another university, and where the top and bottom face halves were aligned or misaligned; holistic processing was indexed by delayed responding to aligned versus misaligned faces. Replicating the perceptual discrimination (Experiments 1, 2, 7) and incidental memory (Experiment 6) experiments reported in this thesis, own-race faces showed equivalent holistic processing regardless of ingroup/outgroup university labelling, and other-race faces showed greater holistic processing following own- than other-university labelling. The replicability of this pattern with a different but related processing manipulation lends further support to the theoretical framework.*

[16] Experiment 8 is reported in Cassidy, K.D., Humphreys, G. W., Quinn, K. A. (in preparation). *Experience and motivation mutually constrain the other-race effect: Evidence from the face face-composite paradigm*.

# 1 Introduction

The experiments reported thus far in the thesis indicate that under conditions of perceptual discrimination (Experiments 1, 2, and 7) and incidental memory encoding (Experiment 6), other-race faces are processed more configurally when categorised as own-university rather than other-university members. In contrast, ingroup/outgroup categorisation has relatively little impact on the configural processing of own-race faces (Experiments 1, 6, 7) unless under conditions of intentional memory encoding (Experiments 5) or when own-race faces are presented within a mono-racial context (Experiment 2). Although supporting my hypotheses, however, it must be noted that the aforementioned results relied exclusively on the face-inversion effect (i.e., impaired responding to inverted versus upright faces) as a marker of configural processing. Whether face inversion truly disrupts configural processing—that is, what information is lost versus spared when a face is rotated-upside down—is a matter of theoretical debate, with potentially limiting implications for my analysis (for reviews, see Rossion, 2008, 2009; Rossion & Gauthier, 2002; Tanaka & Gordon, 2011). This chapter aims to use a different, but related, manipulation to provide additional evidence that ingroup categorisation affects the configural processing of other-race faces.

## 1.1 Effects of Face Inversion

There is general consensus within the literature that upright faces are processed configurally (e.g., Maurer, Le Grand, & Mondloch, 2002; McKone, Martini, & Nakayama, 2001; Rossion & Gauthier, 2002). However, there is far less consensus concerning what information remains after face inversion. While inversion effects have provided a wealth of empirical attention, a limitation of the face inversion paradigm is that the source of inversion interference is not directly manipulated, or specified (Michel et al., 2006; Tanaka & Gordon, 2011). More specifically, the exact cognitive processes that are undermined by rotating a face upside-down are left untested. This has given way to speculation of what exactly underpins the disproportionate effect of inversion for faces.

Classically, face inversion was proposed to selectively disrupt the extraction of configural information from the face, while leaving featural processing unimpaired (e.g., Bartlett & Searcy, 1993; Collishaw & Hole, 2000; Freire, Lee, & Symons, 2000; Leder & Bruce, 2000; Rhodes, Brake, & Atkinson, 1993; Searcy & Bartlett, 1996; Yin, 1969, 1970). In support of this proposal, Freire et al. (2000) manipulated faces either by adjusting the spacing between the eyes and mouth (a configural change) or by replacing the features (i.e., the eyes, nose, and mouth) of an original face with another face (a featural change). In a face discrimination task, participants were asked to indicate whether two faces, presented either upright or inverted, were the same identity as each other or different from each other; face pairs consisted of identical or configurally or featurally manipulated targets (Experiments 1 and 2, respectively). Freire et al. reasoned that if configural processing is disrupted by face inversion, then accuracy for when configurally altered faces should be reduced to chance levels when faces are inverted. They also reasoned that if feature-based processing is spared after face inversion, then accuracy for featurally altered images should be similar in both orientations. Indeed, this is exactly as Freire et al. observed: Inversion affected discrimination accuracy for configurally altered faces but not for featurally altered faces, suggesting that upright and inverted faces are processed in a *qualitatively* different manner.

Elsewhere, however, there is evidence that not all types of configural information are susceptible to face inversion. For example, Goffaux and Rossion (2007) had participants perform a delayed matching task. Specifically, participants were required to match a face that had been manipulated by altering featural information (e.g., eye-shape, surface texture), vertical relations between the eyes (i.e., a vertical configural change), or the horizontal relations of the eyes in the face (i.e., a horizontal configural change) to a target face. The results demonstrated that inversion significantly impaired the perception of vertical-relational changes, but had a much weaker effect on horizontal-relational and feature changes. Goffaux and Rossion suggest that whereas inverted and upright faces may indeed be processed in qualitatively different manner, access to some configural information remains after face inversion. This information might not be useful in aiding recognition or differentiation, however, because perceivers might be unable to apply experience-derived holistic representations to inverted faces (e.g., Rossion, 2008, 2009).

In addition, other researchers have argued that face inversion disrupts feature-based and configural processing equally, suggesting that there is no qualitative difference in processing inverted versus upright faces (e.g., Sekuler, Gasper, Gold, & Bennett, 2004; McKone & Robbins, 2011; McKone & Yovel, 2009; Rhodes et al., 2006; Valentine, 1988, 1991; Yovel & Kanwisher, 2004). Yovel and Kanwisher (2004), for example, made spatial (i.e., configural) changes or changed feature shapes of houses or faces, and asked participants to discriminate between face and house pairs presented in upright and inverted orientations. Yovel and Kanwisher found that the inversion effect was equivalent in both the configural and feature-change task for face discrimination, but was absent when performing both tasks with houses.

Finally, there is also evidence that access to configural information is not lost at all following face inversion. Sekuler Gaspar, Gold, and Bennett (2004), for example, used a psychophysics staircase procedure in which external noise was added to face images, and examined trial-by-trial variation in participants’ responses (i.e., patterns of correct and incorrect responses) to determine how noise in different parts of the stimulus images biased participants toward specific responses. Participants were presented with a target face and then two test faces; their task was to indicate which test face matched the target. The results demonstrated that participants were sensitive to both linear (i.e., feature-based) and nonlinear (i.e., configural) aspects of the stimuli, and for both upright and inverted faces. Sekuler and colleagues concluded that access to configural information is not lost when faces are inverted, but that inversion simply makes the processing of both configural and featural information less efficient—perhaps because of orientation-dependent expertise.

### 1.2 The Face-Composite Effect as an Alternative Processing Index

Resolving these theoretically differing accounts of what is lost or spared after inversion is beyond the scope of this chapter and this thesis. Nonetheless, the debate itself means there is some interpretational ambiguity vis-à-vis that results of the experiments reported thus far in this thesis. In some sense, it makes little difference to my reasoning whether configural information is completely lost or merely rendered less efficient by inversion, in that both accounts would imply that inversion invokes a shift to more (or exclusive) reliance on feature-based processing. Given the controversy regarding whether inversion effects are underpinned solely by disruption to configural processes (i.e., without affecting feature coding), and whether configural processes may still be used even when faces are inverted, I therefore sought an alternative measure of processing for the final experiment. In particular, I chose the face-composite paradigm (Young, Hellawell, & Hay, 1987).

In the face-composite paradigm, participants judge whether the top halves of two faces are identical or different; these faces are connected with bottom halves that are also either identical or different. A reliable outcome is that participants perceive identical top halves of faces as different (or are slower to recognise them as identical) when they are joined with the bottom halves of two different faces (Young et al., 1987). The reasoning is that participants form a "gestalt" or holistic representation of the entire face, such that the top and bottom halves are "fused" into a coherent whole rather than being represented as independent features—interfering with participants' ability to detect that the top halves of the face depict the same identity. Interestingly, this effect disappears when faces are turned upside down or laterally offset (Young et al., 1987). This "face-composite effect" (i.e., the recognition advantage for misaligned over aligned faces) is typically described as a measure of "holistic" processing but, because it divides the face into two halves and thus "breaks" the connection between features (e.g., the eyes and mouth), it can equally be said to measure configural processing. Moreover, because the face-composite paradigm induces a change in the perception of configural information within the same faces, it is subject to less interpretational ambiguity than is face inversion, and may therefore be considered a more direct measure of configural processing (e.g., McKone & Robbins, 2011).

## 2 Experiment 8

Experiment 8 investigated whether the effects of ingroup/outgroup categorisation observed in Experiment 1 would also emerge on a different measure of configural/holistic processing—specifically, the face-composite effect. Participants performed a perceptual discrimination task with pairs of own-race or other-race, aligned or misaligned composite faces. Faces were categorised as being own-university or other-university members. In line with Experiment 1, I predicted that participants would engage in greater holistic processing of ingroup (own-university) than outgroup (other-university) faces. However, given participants' likely greater fluency in the configural processing of own- than other-race races, however, I expected that race salience would mitigate the influence of the non-racial (i.e., university) group membership for the processing of own-race faces. Therefore, I anticipated that evidence for greater holistic processing of own- than other-university faces would emerge more strongly for other-race than own-race faces.

## 2.1 Method

**2.1.1 Participants and design.** Sixty-eight White participants from the University of Birmingham completed the study for course credit; all had normal or corrected-to-normal vision. The data from four participants were removed from the analysis because of an error rate in excess of 20%, leaving 64 participants (49 female; $M_{\text{age}}$ = 19.7 years). The experiment was based on a 2 (target race: own-race, other-race) × 2 (target university: own-university, other-university) × 2 (target alignment: aligned, misaligned) within-participants design.

**2.1.2 Materials.** Face-composites were created from the same materials as in Experiments 1–7. Face stimuli were firstly equated for luminance and contrast and sized to 240 pixels vertically. Face-composites were created by dividing each target face into a top and bottom segment by slicing them in the middle of the nose; thus, the top segment showed the forehead, eyes, and bridge of the nose, and the bottom segment showed the nostrils, mouth, and chin. For each original target face, four composite faces were created: (i) same-aligned, (ii) same-misaligned, (iii) different-aligned, and (iv) different-misaligned.

The "same" composites comprised the top segment of the original face and the bottom segment of another face of the same race. The "different" composites comprised top and bottom segments of other faces of the same race, where the bottom segment was the same as the one used as in the "same" composite for the original target. A gap of 3 pixels was inserted between the top and bottom segments of the composites, which were either aligned so that the top segment was presented directly above the bottom segment or misaligned so that the top segment was offset laterally with the bottom segment

For each target face, there were two "same" response trials (one aligned, one misaligned) and one "different" response trial (across trials, half aligned and half misaligned), resulting in 320 "same" trials and 240 "different" trials. This bias, which was present for both levels of target race and target university, was introduced because only the “same” trials were of interest (e.g., Le Grand et al., 2004; Michel et al., 2006). Each study face appeared as an own-university target for some participants but as an other-university target for others. Each stimulus set contained 560 trials, presented in random order. Figure 15 presents example stimuli.

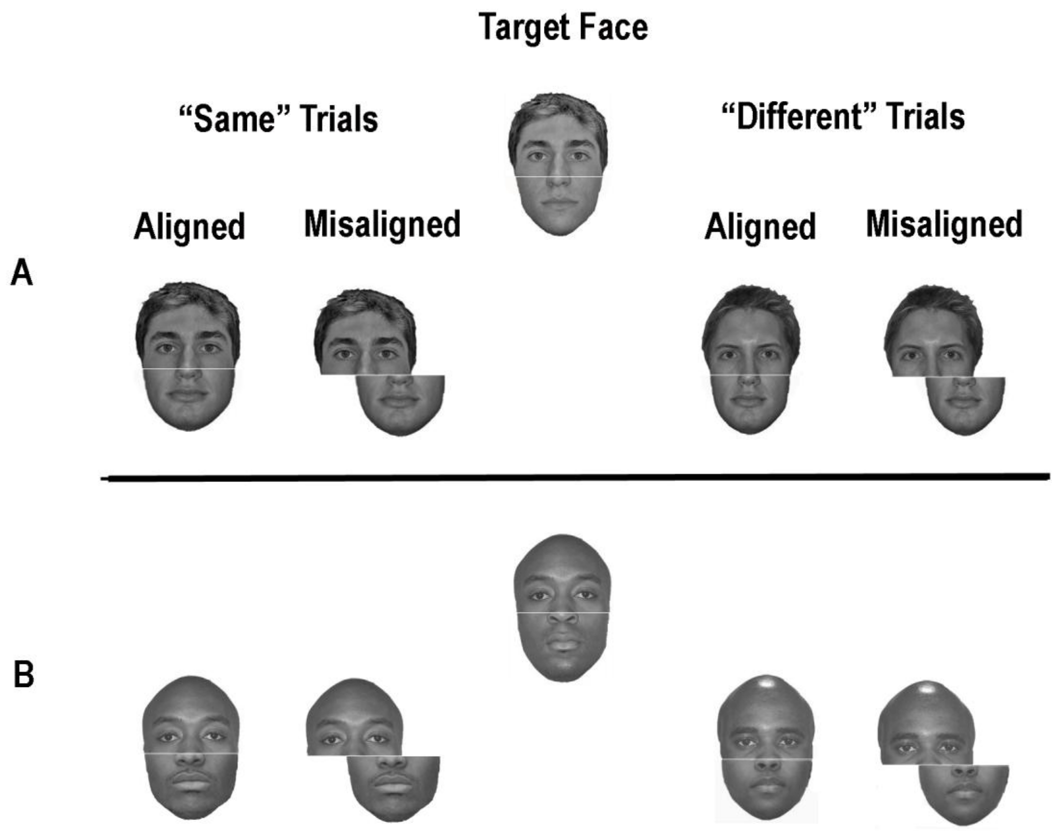


***Figure 15*. Example stimuli, Experiment 8.**

**2.1.2 Procedure.** The procedure was similar to Experiment 1, with the exceptions that target faces were presented sequentially rather than simultaneously. After completing the identity-strengthening task, participants learned that they would see an original photo of a student (the study face) from either the University of Birmingham or the University of

Nottingham, followed by a manipulated photo (the test face). Participants learned that their task was to ignore the lower parts of the face and decide as quickly and as accurately as possible whether the upper half of the test face was the same as, or different from, the upper half of the study face. Each trial sequence contained the following centrally presented events (see Figure 16): a fixation cross (300 ms), a group prime (1500 ms), a target face (600 ms), and a test/composite face that was displayed until participants made a response. The intertrial interval was 1000 ms.

Participants also completed an adapted version of the Hancock and Rhodes (2008) inter-racial contact questionnaire.

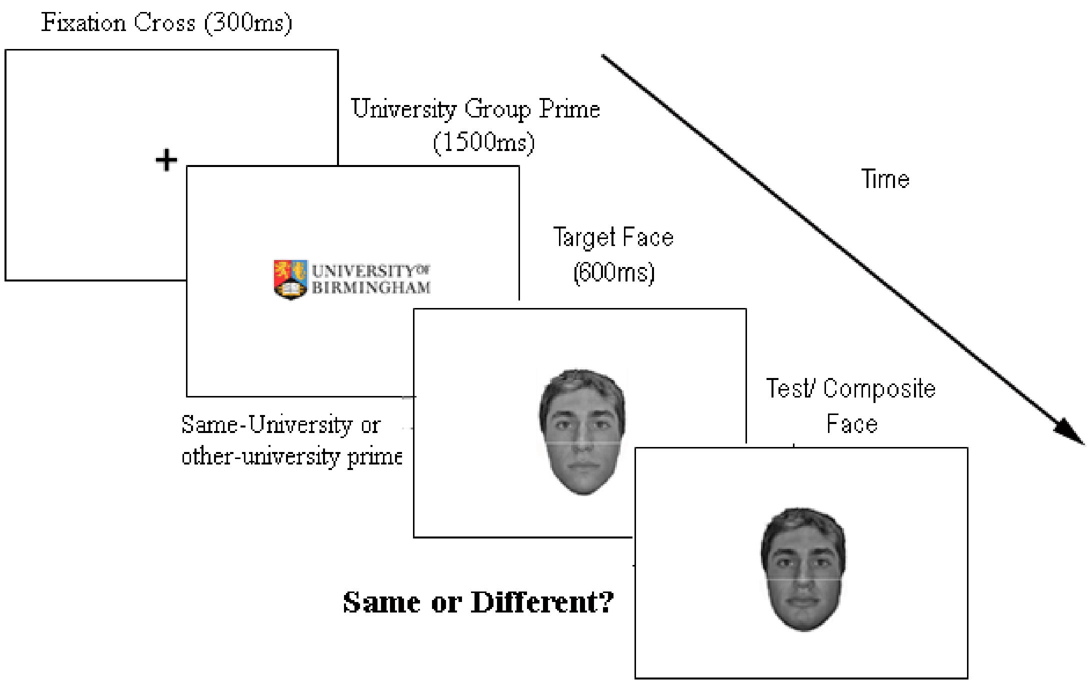


*Figure 16*. **Example trial sequence, Experiment 8.**

## 2.2 Results

**2.2.1 Discrimination latency.** Mean discrimination latencies served as the dependent measure of interest[17]. Due to the presence of outlying responses in the data set, response times over 2.5 standard deviations from the mean were excluded (2.36% of the data), along with trials where errors were committed (8.68% of the data). The data were submitted to a 2 (target race: own-race, other-race) × 2 (target university: own-university, other-university) × 2 (target alignment: aligned, misaligned) repeated measures ANOVA. Condition means and the ANOVA summary table are presented in Appendix FA.

The analysis revealed a significant main effect of target alignment, $F(1, 63) = 128.40$, $p < .001$, $\eta_p^2 = .67$, demonstrating that participants responded more slowly to aligned the misaligned targets (*M*s = 599 and 566 ms, respectively)—the classic face-composite effect. There was also a significant Target University × Target Alignment interaction, $F(1, 63) = 7.38$, $p = .008$, $\eta_p^2 = .11$, demonstrating that participants responded more slowly to aligned than misaligned faces for both own-university, $t(63) = 10.37$, $p < .001$, and other-university targets, $t(63) = 7.39$, $p < .001$; however, face alignment was significantly more disruptive for own-university than other university targets, $t(63) = 2.72$, $p = .008$.

This interaction was subsumed within the predicted Target Race × Target University × Target Alignment interaction, $F(1, 63) = 4.31$, $p = .042$, $\eta_p^2 = .06$ (see Figure 17). I analysed this interaction further by conducting separate Target University × Target Alignment ANOVAs for each target race. For own-race faces, there was a main effect of target alignment only, $F(1, 63) = 69.86$, $p < .001$, $\eta_p^2 = .53$; demonstrating participants were disrupted more when targets were aligned than misaligned (*M*s = 599 and 563 ms, respectively).

[17] Error data were also analysed. Errors were generally low (overall average 8.68 %) and were theoretically uninteresting. For the reader’s interest, however, error analyses are presented in Appendix GA.

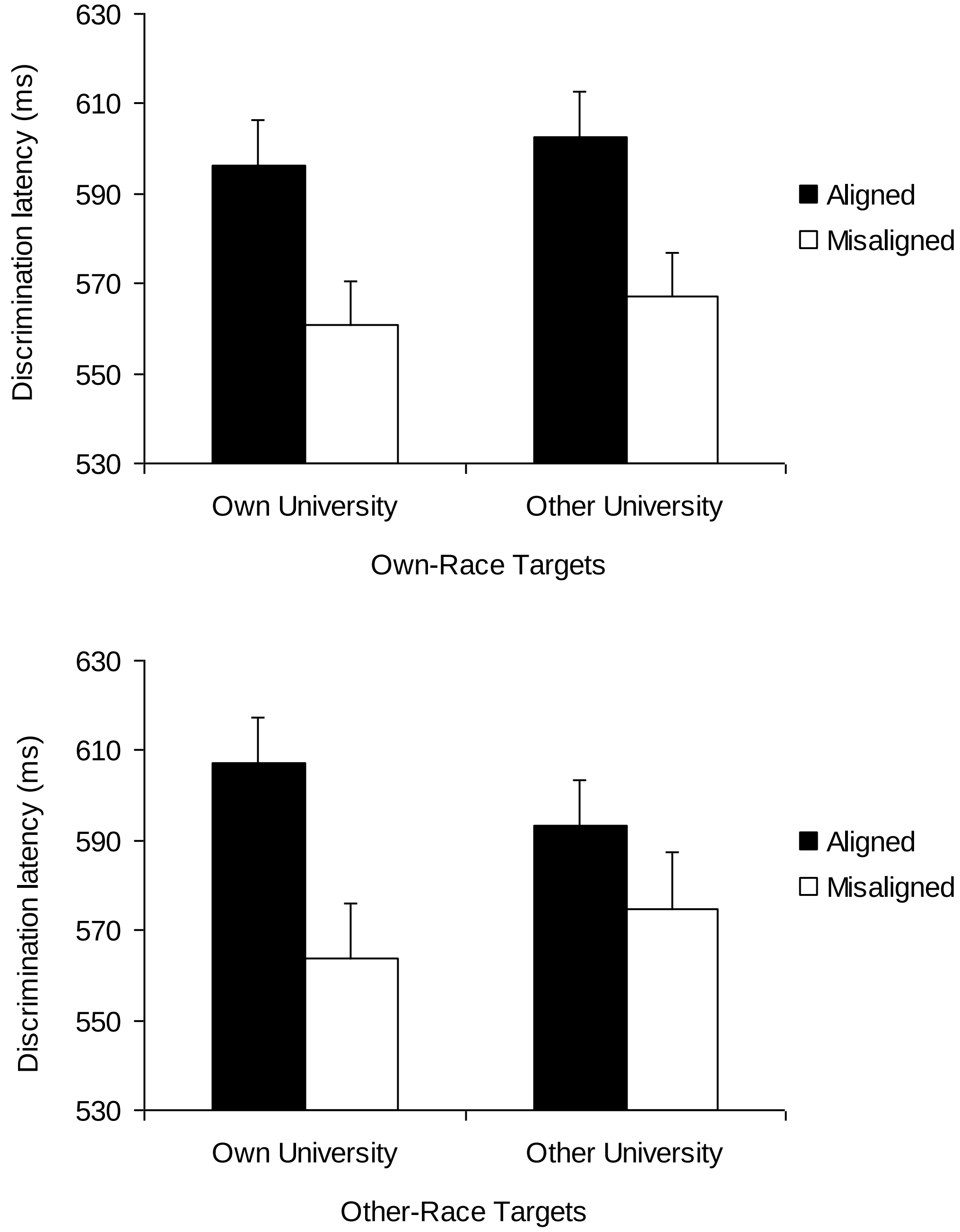


***Figure 17.* Discrimination latencies (ms) as a function of target race, group, and alignment, Experiment 8.** *Note*. Error bars denote standard error.

For other-race faces, the analysis demonstrated a main effect of target alignment, $F(1, 63) = 73.49$, $p = .54$, which was subsumed with a significant Target University × Target Alignment interaction, $F(1, 63) = 10.99$, $p = .002$, $\eta_p^2 = .15$. Participants responded more slowly to aligned than misaligned targets for both own-university, $t(63) = 8.90$, $p < .001$, and other-university targets, $t(63) = 8.88$, $p = .001$; however, as predicted, face-alignment was significantly more disruptive for own-university than other university targets, $t(63) = 3.35$, $p = .001$.

**2.3 Discussion**

Experiment 8 exploited the face-composite effect to investigate the influence of ingroup/outgroup categorisation on the processing of own-race and other-race faces. There were several findings of interest. First, participants were disrupted when targets were aligned relative to when targets were misaligned—the conventional face-composite effect. Second, participants were affected more by target alignment for own-university than other-university targets. Finally, the effect was modulated by target race: For own-race faces, participants were disrupted for aligned versus misaligned targets to an equal extent regardless of own- or other-university status. In contrast, for other-race faces, participants were disrupted for aligned versus misaligned targets more for own-university targets than other-university targets.

The results of Experiment 8 replicate the findings from the perceptual discrimination (Experiments 1, 2, 7; Chapters 2 and 4) and incidental memory (Experiment 6; Chapter 3) experiments reported in this thesis: Own-race faces showed equivalent holistic processing regardless of ingroup/outgroup university labelling, and other-race faces showed greater holistic processing following own- than other-university labelling. This pattern is consistent with the Categorisation–Individuation Model's general hypothesis that experience and motivation interact to determine processing: As a result of immeasurable experience with own-race faces, the “default” configural/holistic processing of own-race faces is sufficiently fluent as to proceed unencumbered by the motivational effects of ingroup/outgroup categorisation. The relative lack of experience with other-race faces, however, means that configural/holistic processing is less likely to occur—unless some factor (e.g., ingroup categorisation) prompts the motivation to individuate these faces.

Given that the face-composite paradigm is considered a more direct manipulation of configural processing than face-inversion (e.g., McKone & Robbins, 2011), the replication of the inversion effects with the face-composite paradigm indicates that the results reported earlier in this thesis cannot be explained exclusively in terms of delayed rather than disrupted configural processing (e.g., McKone et al., 2009, 2011; Sekuler et al., 2004). This replication supports the argument that ingroup categorisation—on the basis of race or other salient group memberships—prompts configural/holistic (although the effects of this strategy choice are constrained by experience).

# CHAPTER 6

# GENERAL DISCUSSION

*The current chapter summarises the studies reported within this thesis. The current thesis aimed to understand the impact of non-racial ingroup/outgroup categorisation on the other-race effect and to examine factors that might modulate this impact. . Several studies indicated that own- versus other-university categorisation affected the processing of other-race faces more than own-race faces (Experiments 1, 6, 7, 8), indicating that ingroup/outgroup categorisation can shift reliance on configural versus feature-based processes, but that this impact might be limited by experience (such that more experience with own-race faces offsets the effect of non-racial categorisation on the processing of own-race faces). These effects can also be seen in recognition of own- and other-race faces (Experiment 4, 6). Importantly, however, these effects are modulated by context (Experiments 1–2) and encoding conditions (Experiments 3–6). The implications of these findings for the recent Categorisation–Individuation Model (Hugenberg et al., 2010), and the wider theoretical and practical implications for our understanding of the other-race effect are discussed.*

## 1 Background and Aims of the Thesis

The Categorisation–Individuation Model (Hugenberg et al., 2010) argues the other-race effect is underpinned by an absence of motivation to individuate other-race individuals. As such, the Categorisation–Individuation Model argues that if sufficient motivation or cues to individuation are provided to the perceiver, then the other-race effect should disappear, or at least should be reduced (e.g., Hugenberg et al., 2010). It assumes further that without sufficient experience in discriminating other-race faces, successful individuation is likely to be limited.

The model successfully integrates several diverse accounts of the other-race effect, but what remains missing is a clear account of *when* and *how* individuation experience constrains the motivation to individuate own- and other-race members. The overarching aim of this thesis was to investigate the additional signalling cues that affect own- and other-race face processing. More specifically, the thesis aimed to (1) understand the role of racial context in determining the effects of ingroup/outgroup categorisation on own-race and other-race face processing; (2) explore the role of perceiver goals and ongoing task demands in determining the processing of ingroup/outgroup own-and other-race faces; and finally, (3) investigate the time course of racial and non-racial ingroup/outgroup status effects.

## 2 Summary of Findings

### 2.1 Perceptual Discrimination and Recognition of Own- and Other-Race Faces

In Chapter 2, I aimed to investigate the impact of ingroup/outgroup categorisation as a function of inter-versus intra-racial context on the perceptual processing of own- and other-race faces. In the research reported in this chapter, participants performed simple same/different judgements on pairs of own- versus other-race faces, which were categorised as own-university or other-university members. Experiment 1 demonstrated that in an inter-racial context, cues to own-university categorisation resulted in other-race faces being processed more configurally than other-university faces. Own-race faces were processed configurally irrespective of cues to group membership. Experiment 2, in contrast, indicated that in a mono-racial context, own-university faces were processed more configurally than other-university faces, irrespective of race. Taken together, these results provide broad support for the Categorisation–Individuation Model (Hugenberg et al., 2010), in that situational cues influenced the processing of other-race and own-race faces (in this case via inter- versus intra-racial context). However, these results add to the model and current body of the literature, by suggesting the processing of other-race faces is more flexible (e.g., McKone et al., 2007) and that sensitivity to ingroup/outgroup status does not depend on extensive other-race experience (i.e., the findings were not moderated by other-race contact).

Mindful that situational cues influence the likelihood of either categorisation or individuation (as indicated in Chapter 2), Chapter 3 aimed to expand on these findings, by investigating how encoding goals influence the impact of ingroup/outgroup categorisation on own-race and other-race face processing and memory. Participants judged faces for likeability (in an incidental memory task, Experiments 4, 6) or encoded them for later recognition (a memory-directed task, Experiments 3, 5). The memory and processing data again demonstrated clear evidence that situational cues (in this case, encoding goals) modulate the impact of ingroup/outgroup categorisation. With a memory-related goal, other-university categorisation, relative to own-university categorisation, resulted in poorer memory for own-race faces, but had no effect on memory for other-race faces (Experiment 3); this effect of outgroup categorisation on memory for own-race faces was underpinned by less reliance on default configural processing (Experiment 5). In contrast, when participants evaluated faces for likeability (a trait-directed encoding goal), the memory data indicated that own- versus other-university categorisation had no effect on own-race recognition, but that other-university categorisation resulted in poorer recognition for other-race faces. In this case, the processing data (Experiment 6) clearly indicated strong reliance on configural processing for own-race faces irrespective of university affiliation, and for own-university other-race own-university. These data clearly support the assertion that recognition is affected by encoding-related cues, but also extend the Categorisation–Individuation Model by suggesting such cues operate by encouraging either more or less reliance on configural processing. Again, these results were not explained by participants' interracial experience.

If the motivation attributable to ingroup/outgroup categorisation can indeed change the way other-race and own-race faces are processed, it seemed liked that this would be reflected at the electrophysiological level, perhaps even at early stages of structural encoding. Chapter 4 investigated the electrophysiological correlates of ingroup/outgroup categorisation on own- and other-race face processing using a similar same/different perceptual matching task as in Experiment 1. The behavioural data pattern replicated Experiment 1, whereby own-university categorisation affected the processing of other-race faces more than own-race faces. More interesting was the electrophysiological data. The P100 demonstrated effects of face orientation, but neither racial nor non-racial ingroup/outgroup status influenced this early stage of feature analysis. In contrast, there was clear evidence of both racial and non-racial group effects on the N170, which is presumed to reflect structural encoding and configural processing (e.g., Bentin et al., 1996; Liu et al., 2002). The pattern of N170 latencies, in particular, matched the behavioural pattern: For other-race faces, the N170 was delayed for inverted relative to upright faces, but only for own-university targets. In contrast, for own-race faces, the N170 was delayed for inverted relative to upright faces irrespective of university affiliation. The later P200 component demonstrated no such interactions. These results indicate that ingroup/outgroup categorisation influences the way in which other-race faces are structurally encoded.

Finally, Chapter 5 acknowledged the limitation in the foregoing studies of relying solely on inversion effects as a marker of configural processing (McKone & Robbins, 2011; McKone & Yovel, 2009; Rhodes et al., 2006; Valentine, 1988, 1991; Yovel & Kanwisher, 2004). The final experiment investigated the impact of own-university versus other-university categorisation on the holistic processing of own- and other-race faces using face composites rather than inverted faces. The results demonstrated that, irrespective of target group, own-race faces were processed holistically. In contrast, other-race faces were processed more holistically when they were categorised as own-university rather than other-university members. This pattern was consistent with the other incidental memory experiments reported in this thesis (Experiments 1, 2, 4, 6, 7), thereby strengthening the argument that ingroup/outgroup categorisation has implications for the relative reliance on configural versus featural facial information.

## 3 Theoretical Implications: The Categorisation–Individuation Model

In Chapter 1, I identified three limitations in the Categorisation–Individuation Model. First, the model is relatively vague about factors that might heighten or diminish the signalling function of ingroup-/outgroup-specifying information. This is not a limitation per se, but it does leave room for theoretical refinement. In Chapter 2, I identified racial context as a variable that possesses a signalling function. For example, when own-race and other-race faces are presented intermixed (effectively creating an interracial context), ingroup categorisation affected the processing of other-race faces more than own-race faces (Experiment 1). In contrast, when faces were presented in an intra-racial context (i.e., blocked by race), ingroup categorisation moderated processing irrespective of racial status (replicating the effect of ingroup categorisation on White faces observed by Hugenberg & Corneille, 2009). This suggests that when processing own-race faces, perceivers are sensitive to racial-contextual cues, and that this directly undermines the effects of categorisation on processing; that is, when race is highlighted, perceivers see own-race faces as ingroup faces, regardless of other ingroup/outgroup cues. In contrast, other-race faces are sensitive to cues of ingroup versus outgroup categorisation irrespective of the racial context. These results cannot be accounted for by participants' interracial experience (as there was no evidence for a link between contact and performance) and, as I employed a perceptual matching task, the effects are not constrained by differences in participants' memory performance. Instead, these results suggest a potential extension to the Categorisation–Individuation Model, namely, that during perceptual encoding, other-race faces are more sensitive to cues of ingroup/outgroup categorisation, resulting in the greater motivated allocation of configural processing following ingroup categorisation. This is supportive of evidence suggesting that the processing of other-race faces is generally rather flexible (McKone et al., 2007).

Second, the model links ingroup categorisation with the motivation to individuate, and individuation with configural processing, but presents little direct evidence for a link between ingroup categorisation and configural processing. One exception is the recent evidence from Hugenberg and Corneille (2009) that for own-race faces, ingroup categorisation prompts more holistic processing than does outgroup categorisation. Nonetheless, this is only one demonstration, and to date there is no evidence of whether the same link would emerge with other-race faces, which tend to be processed less configurally (e.g., Michel et al., 2006, 2007, 2009; Tanaka et al., 2004). Over several studies, I demonstrated that ingroup categorisation results in greater configural processing (i.e., larger inversion effects) of other-race faces. For example, in Chapter 2, ingroup other-race faces were processed more configurally than outgroup other-race faces, irrespective of inter- or interracial context (Experiments 1 and 2, respectively). Further, this pattern was not restricted to perception: In Experiment 6, participants judged faces for likeability, and demonstrated greater configural processing of own-university than other-university targets at subsequent recognition. Finally, this pattern was not explained by reliance on face-inversion effects: I replicated the effects in Experiment 7 with a measure of holistic processing (i.e., face-composite effects). Across all experiments, these effects were not moderated by participants' inter-racial contact, suggesting that given sufficient motivation one can configurally process other-race faces even in the absence of experience.

Finally, the model also assumes that only ingroup-/outgroup-specifying information is relevant in determining perceivers' motivation to individuate faces—or, at least, ingroup-/outgroup-specifying information is the only factor that is discussed in the model's presentation. It is possible, however, that other factors (e.g., encoding goals, task requirements) can prompt more or less configural processing, and thus more or less of the "types" of processing that support individuation. In Chapter 3, I demonstrated that encoding goals can interact with racial and non-racial ingroup/outgroup categorisation to promote or impede configural processing. For example, when faces were coded intentionally for later recognition (Experiments 3, 5), ingroup (versus outgroup) categorisation resulted in a greater recognition of own-race faces but had no effect on other-race recognition. In contrast, when participants coded faces for likeability (an incidental non-memory-related judgement; Experiment 4), ingroup (versus outgroup) categorisation results in greater recognition of other-race faces, but had no effect on recognition of own-race faces. These results were explained by a reduced reliance on configural information when coding faces for memory (as indicated by null or reversed inversion effects; Experiment 5) and a more "normal" reliance on configural information when making non-memory-related judgements (Experiment 6). This suggests that different types of task modulate the successful implementation of configural processing. For example, it seems that intentional memory—at least as operationalised in my experiments—is optimal for the categorisation of faces, both by racial and non-racial group, whereas incidental encoding is optimal for individuation (and is more likely to be recruited for ingroup than outgroup targets), and these processes prompt different degrees of configural processing.

## 4 Caveats and Limitations

In addition to the criticism that the research reported in Chapter 2–4 relied solely on inversion effects as evidence of configural processing—which I addressed in Chapter 5—there are a few additional limitations that must be noted.

### 4.1 Null Effects for Inter-Racial Contact

In none of the experiments reported in this thesis did I find evidence that inter-racial contact modulated other-race face processing. Although it makes intuitive sense that the quantity and/or quality of contact should have implications for other-race face processing—and indeed there is evidence to support this hypothesis (Brigham, Maass, Snyder, & Spaulding, 1982; Carroo, 1986, 1987)—similar null effects have been reported elsewhere in the literature (e.g., Luce, 1974; Malpass & Kravitz, 1969; Ng & Lindsay, 1994). Understanding when and how contact relates to other-race face processing remains to be determined.

### 4.2 Sampling Limitations

There are two sampling limitations that characterise the research reported in this thesis. First, *a*ll of our participants were White. A complete investigation of the other-race effect would require examining the performance of non-White participants. This would be critical, first, in establishing whether the current results would generalise to members of other racial groups. Importantly, however, crossover interactions in own-race and other-race face processing as a function of participant race are not always observed (e.g., Lindsay, Jack, & Christian, 1999; Tanaka et al., 2004; Walker & Hewstone, 2006). This has been attributed to the fact that non-White participants are typically familiar with White faces (and more familiar with White faces than White participants are with non-White faces). Any attempt to replicate the findings of this thesis with non-White participants would need to take into account this confounding factor.

Replicating the current findings with other racial categories would also be useful for ruling out confounds arising from stimulus characteristics. That is, the use of non-White participants would allow me to independently verify that the two sets of faces (White and Black) are equivalent in factors such as discriminability. However, this should pose no concern to the reader for several reasons. First, all of the face stimuli used in the current research were taken from previous research (e.g., Shriver et al., 2008, 2010), or from face databases (Eberhardt et al., 2006; Minear & Park, 2004). Indeed, these faces have been used in many studies of face processing (e.g., Brebner et al., 2011; Eberhardt, 2005; Eberhardt et al., 2006; Hehman et al., 2011; Stahl et al., 2008; Vizioli et al., 2010; Weise et al., 2009; Weise, Schweinberger, & Hansen, 2008) and studies using own- and other-race participants (e.g., Eberhardt, 2005; Eberhardt et al., 2006; Stahl et al., 2008; Vizioli et al., 2010 ). Therefore, it is unlikely that the results within this thesis are explained by simple differences in discriminability as a function of target race. Further, it is worth noting that studies supporting the Categorisation–Individuation Model have also used some of the same stimuli, and did not employ other-race participants (Bernstein et al., 2007; Shriver et al., 2008; 2010; Young et al., 2009; 2010; 2011). Therefore, any criticism of the sample and stimuli would be equally applicable to these studies.

The second sampling limitation is that the vast majority of my participants were female. Navarrete, McDonald, Molina, and Sidanius (2010) recently proposed that different psychological systems underpin intergroup bias for women and men, with women motivated by sexual coercion fears and men motivated by aggression and dominance motives. Whether these differing motives would have different outcomes for face processing is unclear. Indeed, just as fearful and angry expressions capture attention (Vuilleumier, 2002), it would seem plausible that both fear and dominance motivation should motivate attention, particularly to outgroup faces. Moreover, to the best of my knowledge, there is no evidence for gender differences in same- versus other-race face processing in general, nor is there evidence in the available literature to suggest that perceiver sex moderates the finding that face inversion is more disruptive to the processing of same-race than other-race faces. Together, these factors suggest my findings are unlikely to be subject to gender differences. Nonetheless, this remains an empirical question that should be subjected to future scrutiny.

## 5 Future Directions

### 5.1 Configural/Featural or Global/Local?

Chapter 3 demonstrates that intentional versus incidental memory encoding has consequences not only for the way in which individuals process own-race and other-race faces, but also for the effectiveness of motives to individuate targets, as determined by group categorisation. I have interpreted these findings as providing evidence that memory-directed and non-memory-directed encoding goals recruit different processes (emphasising feature-based and configural information, respectively), or at least reduce the reliance on configural processing. An alternative explanation could be that evaluating faces for likeability (as in Experiments 4 and 6) recruits more “global” processing (McKelvie 1991, 1995, 1996), and this results in other-race faces being remembered better, particularly when cues to non-racial ingroup status are present (as the experiments reported within this thesis). Equally as likely, when faces are encoded specifically for later recognition, this could result in a more local-based processing strategy. For example, there is evidence that when participants respond to the local aspects of Navon letters (i.e., a large letter made up of smaller letters), face recognition is impaired (e.g., Macrae & Lewis, 2002). Whether such local versus global task switching underpins the effects reported in Experiment 3 remains an area for empirical research.

### 5.2 The Nature of Recognition

Throughout this thesis, I have assumed that recognition performance implies *identity* recognition; this may not be the case. For example, recent studies have demonstrated that perceivers are remarkably poor at matching unfamiliar targets to different photos of the same target (e.g., Bruce et al., 1999; 2001; for a review, see Burton & Jenkins, 2011). That is, unless a face is relatively familiar, perceivers are actually rather poor at identifying individuals across multiple images. In this thesis, as in much previous research (e.g., Shriver et al., 2007), I relied exclusively on the same images at study and test to investigate perceptual discrimination and subsequent recognition. It thus remains unclear whether I was testing participants' ability to individuate on the basis of identity or on the basis of perceptual image; indeed, both are possible. This raises interesting questions for future research: Does categorisation-derived motivation increases the likelihood of individuation on the basis of identity or percept? Is it possible that it depends whether the target is an own-race or other-race face? Perhaps ingroup categorisation of own-race faces induces "true" individuation (i.e., in terms of identity), whereas ingroup categorisation of other-race faces induces attempts to individuate at the more superficially image level. Understanding the link between categorisation-driven motivation and individuation would be a fruitful avenue for future research.

## 6 Conclusion

The aim of this thesis was to investigate non-racial ingroup/outgroup categorisation, inter-/intra-racial context, and encoding conditions as signalling cues that affect own- and other-race face processing. Across eight experiments using both behavioural and neuroimaging methods, I have demonstrated (1) that the context in which own- and other-race faces are encountered can determine the salience of racial category membership, with implications for how (and how much) non-racial ingroup/outgroup status influences own- and other-race face perception, (2) that encoding goals can lead perceivers toward more or less configural processing regardless of target ingroup/outgroup status, with implications for the influence of non-racial ingroup/outgroup status, and (3) that both racial and non-racial ingroup/outgroup status have the potential to influence early stages of face perception. These findings both support and extend the Categorisation–Individuation Model, yielding a more comprehensive insight into the other-race effect.

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## Appendix A

## Adapted Inter-group Process Questionnaire (Voci & Hewstone; 2003)

*Quantity of Contact Stem Statements (five point scales):*

How many people from Afro-Caribbean's do you know? (None-More than 10)
How frequently do you have contact Afro-Caribbean's? (Never- very frequently)
How many Afro-Caribbean students do you know? (None- more than 10)
How frequently do you have contact with Afro-Caribbean students? (Never- Very frequently)

*Quality of contact Stem statements (five points Scales):*

When you meet Afro-Caribbean Students, in general do you find the contact pleasant? (*Not at all—Very*)
When you meet Afro-Caribbean Students, in general do you find the contact cooperative? *(Not at all — Very)*
When you meet Afro-Caribbean Students, in general do you find the contact superficial? *(Not at all — Very*

## Appendix B

*ANOVA Summary: Experiment 1, Discrimination Latencies (ms)*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Trial Type (A) | 78394.64 | 1 | 1.88 | 0.179 |
| Race (B) | 3502.79 | 1 | 0.20 | 0.658 |
| University (C) | 2530.84 | 1 | 0.250 | 0.621 |
| Orientation (D) | 793241.936 | 1 | 48.23 | 0.001 |
| A × B | 227.59 | 1 | 0.045 | 0.834 |
| A × C | 163253.97 | 1 | 35.77 | 0.001 |
| A × D | 15255.98 | 1 | 1.63 | 0.210 |
| B × C | 12398.17 | 1 | 1.39 | 0.246 |
| B × D | 789.46 | 1 | 0.14 | 0.706 |
| C × D | 9027.90 | 1 | 3.17 | 0.085 |
| A × B × C | 28584.19 | 1 | 7.65 | 0.009 |
| A × B × D | 13972.72 | 1 | 2.37 | 0.134 |
| A × C × D | 2625.35 | 1 | 0.54 | 0.465 |
| B × C × D | 31840.48 | 1 | 7.57 | 0.010 |
| A × B × C × D | 5796.74 | 1 | 1.85 | 0.183 |
| Error (A/within) | 1286794.86 | 31 | | |
| Error (B/within) | 544203.77 | 31 | | |
| Error (C/within) | 313773.33 | 31 | | |
| Error (D/within) | 509802.99 | 31 | | |
| Error (A × B/within) | 157867.44 | 31 | | |
| Error (A × C/within) | 141451.83 | 31 | | |
| Error (A × D/within) | 288754.50 | 31 | | |
| Error (B × C/within) | 275408.95 | 31 | | |
| Error (B × D/within) | 169294.93 | 31 | | |
| Error (C × D/within) | 88180.30 | 31 | | |
| Error (A × B × C /within) | 115802.43 | 31 | | |
| Error (A × B × D /within) | 13972.72 | 31 | | |
| Error (A × C × D /within) | 148799.57 | 31 | | |
| Error (B × C × D /within) | 130301.02 | 31 | | |
| Error (A × B × C × D /within) | 96969.45 | 31 | | |

Average discrimination latencies (ms) as a function of Trial Type, Race, Group and Orientation, Experiment 1.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | | | | |
| Same Trial | 900 (34.50) | 949 (37.77) | 931 (34.08) | 991 (56.05) |
| Different Trial | 955 (43.28) | 1043 (50.86) | 880 (49.45) | 987 (57.04) |
| Other Race (Black) | | | | |
| Same Trial | 876 (31.45) | 970 (39.48) | 915 (34.50) | 983 (40.84) |
| Different Trial | 911 (30.64) | 1029 (45.69) | 932 (42.29) | 978 (40.74) |

*Note*. Numbers in parentheses represent standard error.

**Appendix C**

*ANOVA Summary: Experiment 1, Average Errors*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Trial Type (A) | 0.060 | 1 | 4.79 | 0.036 |
| Race (B) | 0.001 | 1 | 0.34 | 0.564 |
| University (C) | 0.017 | 1 | 6.65 | 0.015 |
| Orientation (D) | 0.178 | 1 | 27.13 | 0.001 |
| A × B | 2.67 | 1 | 1.13 | 0.295 |
| A × C | 24.93 | 1 | 19.57 | 0.001 |
| A × D | 39.93 | 1 | 13.49 | 0.001 |
| B × C | 46.92 | 1 | 25.29 | 0.001 |
| B × D | 1.87 | 1 | 1.11 | 0.300 |
| C × D | 3.28 | 1 | 2.41 | 0.130 |
| A × B × C | 15.47 | 1 | 14.88 | 0.001 |
| A × B × D | 1.87 | 1 | 1.23 | 0.275 |
| A × C × D | 10.98 | 1 | 7.45 | 0.010 |
| B × C × D | 7.26 | 1 | 7.40 | 0.011 |
| A × B × C × D | 6.79 | 1 | 4.72 | 0.38 |
| Error (A/within) | 0.060 | 31 | | |
| Error (B/within) | 0.069 | 31 | | |
| Error (C/within) | 0.080 | 31 | | |
| Error (D/within) | 0.230 | 31 | | |
| Error (A × B/within) | 0.127 | 31 | | |
| Error (A × C/within) | 0.069 | 31 | | |
| Error (A × D/within) | 0.159 | 31 | | |
| Error (B × C/within) | 0.100 | 31 | | |
| Error (B × D/within) | 0.091 | 31 | | |
| Error (C × D/within) | 0.073 | 31 | | |
| Error (A × B × C /within) | 0.003 | 31 | | |
| Error (A × B × D /within) | 0.082 | 31 | | |
| Error (A × C × D /within) | 0.079 | 31 | | |
| Error (B × C × D /within) | 0.053 | 31 | | |
| Error (A × B × C × D /within) | 0.077 | 31 | | |

Average errors committed as a function of Trial Type, Race, Group and Orientation, Experiment 1.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | | | | |
| Same Trial | 0.05 (0.01) | 0.04 (0.01) | 0.04 (0.01) | 0.05 (0.01) |
| Different Trial | 0.06 (0.01) | 0.16 (0.02) | 0.03 (0.01) | 0.05 (0.01) |
| Other Race (Black) | | | | |
| Same Trial | 0.03 (0.01) | 0.05 (0.01) | 0.04 (0.01) | 0.07 (0.01) |
| Different Trial | 0.03 (0.01 | 0.09 (0.19) | 0.04 (0.01) | 0.10 (0.16) |

*Note*. Numbers in parentheses represent standard error.

**Appendix D**

Correlations between self reported quality and quantity of contact reaction time inversion costs for own and other-university other-race targets, Experiment 1.

| | Quantity of Contact | | Quality of Contact | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Own University (Birmingham) | -0.02 | 0.90 | -0.01 | 0.93 |
| Other University (Nottingham) | -0.06 | 0.71 | -0.32 | 0.07 |

## Appendix E

*ANOVA Summary: Experiment 2, discrimination latency (ms). Note that the 'condition' is a between-participants factor*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Trial Type (A) | 120346.01 | 1 | 6.87 | 0.012 |
| Race (B) | 24.800 | 1 | 0.001 | 0.978 |
| University (C) | 8970.7 | 1 | 3.22 | 0.080 |
| Orientation (D) | 380605.82 | 1 | 52.19 | 0.001 |
| Condition (E) | 193777.21 | 1 | 0.70 | 0.405 |
| | | | | |
| A × B | 24127.42 | 1 | 4.28 | 0.045 |
| A × C | 32455.51 | 1 | 11.077 | 0.002 |
| A × D | 22310.93 | 1 | 5.85 | 0.020 |
| B × C | 5048.31 | 1 | 1.94 | 0.170 |
| B × D | 149.67 | 1 | 0.03 | 0.861 |
| C × D | 12359.94 | 1 | 12.17 | 0.001 |
| | | | | |
| A × E | 2208.19 | 1 | 0.126 | 0.724 |
| B × E | 255309.98 | 1 | 7.86 | 0.008 |
| C × E | 5837.56 | 1 | 2.10 | 0.155 |
| D × E | 11620.07 | 1 | 1.59 | 0.214 |
| | | | | |
| A × B× E | 13751.29 | 1 | 2.44 | 0.125 |
| A × C× E | 446.35 | 1 | 0.15 | 0.698 |
| A × D× E | 142.09 | 1 | 0.03 | 0.848 |
| B × C × E | 23.42 | 1 | 0.009 | 0.925 |
| B × D× E | 8389.70 | 1 | 1.74 | 0.194 |
| C × D× E | 593.22 | 1 | 0.58 | 0.449 |
| | | | | |
| A × B × C | 3730.19 | 1 | 1.93 | 0.171 |
| A × B × D | 3912.14 | 1 | 1.34 | 0.254 |
| A × C × D | 1026.40 | 1 | 0.33 | 0.564 |
| B × C × D | 79.06 | 1 | 0.053 | 0.819 |
| | | | | |
| A × B × C × D | 242.10 | 1 | 0.78 | 0.782 |
| | | | | |
| A × B × C × E | 10552.53 | 1 | 5.48 | 0.024 |
| A × B × D × E | 657.14 | 1 | 0.225 | 0.638 |
| A × C × D × E | 3253.37 | 1 | 1.07 | 0.306 |
| B × C × D × E | 231.41 | 1 | 0.155 | 0.696 |
| | | | | |
| A × B × C × D × E | 523.87 | 1 | 0.168 | 0.684 |
| | | | | |
| Error (A/within) | 735356.22 | 42 | | |
| Error (B/within) | 24.80 | 42 | | |
| Error (C/within) | 116683.78 | 42 | | |
| Error (D/within) | 306251.39 | 42 | | |
| | | | | |
| Error (A × B/within) | 236271.29 | 42 | | |
| Error (A × C/within) | 123062.92 | 42 | | |
| Error (A × D/within) | 160074.34 | 42 | | |
| Error (B × C/within) | 108932.60 | 42 | | |
| Error (B × D/within) | 202258.89 | 42 | | |

| | | |
|---|---|---|
| Error (C × D/within) | 42646.33 | 42 |
| Error (A × B × C /within) | 80799.45 | 42 |
| Error (A × B × D /within) | 122661.25 | 42 |
| Error (A × C × D /within) | 127297.77 | 42 |
| Error (B × C × D /within) | 62773.21 | 42 |
| Error (A × B × C × D /within) | 130595.16 | 42 |
| Error (A× E/between) | 735356.22 | 42 |
| Error (B× E/between) | 24.80 | 42 |
| Error (C× E/between) | 116683.78 | 42 |
| Error (D× E/between) | 306251.39 | 42 |
| Error (A × B × E/between) | 236271.29 | 42 |
| Error (A × C × E/between) | 123062.92 | 42 |
| Error (A × D × E/between) | 160074.34 | 42 |
| Error (B × C × E/between) | 108932.60 | 42 |
| Error (B × D × E/between) | 202258.89 | 42 |
| Error (C × D × E/between) | 42646.33 | 42 |
| Error (A × B × C × E /between) | 80799.45 | 42 |
| Error (A × B × D × E /between) | 122661.25 | 42 |
| Error (A × C × D × E /between) | 127297.77 | 42 |
| Error (B × C × D × E/between) | 62773.21 | 42 |
| Error (A × B × C × D × E /between) | 130595.16 | 42 |

Average latency (ms) when the white face (own-race) block appeared first, as a function of Trial Type, Race, Group and Orientation, Experiment 1.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | | | | |
| Same Trial | 790 (29.85) | 843 (34.11) | 823 (29.05) | 857.14 (36.87) |
| Different Trial | 850 (26.67) | 939 (32.83) | 829 (26.5) | 895 (33.74) |
| Other Race (Black) | | | | |
| Same Trial | 776 (29.22) | 836 (38.65) | 801 (33.47) | 831 (41.73) |
| Different Trial | 789 (25.93) | 847 (31.64) | 799 (29.99) | 846 (31.67) |

*Note.* Numbers in parentheses represent standard error.

Average latency (ms) when the black (other-race) face block appeared first, as a function of Trial Type, Race, Group and Orientation, Experiment 1.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | | | | |
| Same Trial | 754 (29.85) | 768 (34.11) | 769 (29.99) | 786 (36.87) |
| Different Trial | 767 (26.67) | 823 (32.83) | 777 (26.54 | 812 (33.74) |
| Other Race (Black) | | | | |
| Same Trial | 775.57 (29.22) | 813 (38.65) | 809 (33.47) | 845 (41.73) |
| Different Trial | 793 (25.93) | 865 (31.64) | 812 (29.99) | 852 (31.67) |

*Note*. Numbers in parentheses represent standard error.

**Appendix F**

*ANOVA Summary: Experiment 2, Errors Analysis. Note that the 'condition' is a between-participants factor*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Trial Type (A) | 153.27 | 1 | 12.08 | 0.001 |
| Race (B) | 6.98 | 1 | 5.38 | 0.025 |
| University (C) | 0.45 | 1 | 0.263 | 0.611 |
| Orientation (D) | 101.85 | 1 | 42.83 | 0.001 |
| Condition (E) | 28.92 | 1 | 1.47 | 0.232 |
| | | | | |
| A × B | 24.84 | 1 | 10.79 | 0.002 |
| A × C | 41.27 | 1 | 15.86 | 0.001 |
| A × D | 66.74 | 1 | 14.00 | 0.001 |
| B × C | 18.12 | 1 | 6.60 | 0.014 |
| B × D | 9.70 | 1 | 4.02 | 0.051 |
| C × D | 3.12 | 1 | 2.55 | 0.118 |
| | | | | |
| A × E | 3.69 | 1 | 0.30 | 0.581 |
| B × E | 1.17 | 1 | 0.90 | 0.348 |
| C × E | 0.13 | 1 | 0.07 | 0.784 |
| D × E | 1.69 | 1 | 0.71 | 0.403 |
| | | | | |
| A × B× E | 4.07 | 1 | 1.77 | 0.191 |
| A × C× E | 0.83 | 1 | 0.32 | 0.575 |
| A × D× E | 0.32 | 1 | 0.06 | 0.795 |
| B × C × E | 0.26 | 1 | 0.095 | 0.759 |
| B × D× E | 0.213 | 1 | 0.08 | 0.768 |
| C × D× E | 0.33 | 1 | 0.27 | 0.606 |
| | | | | |
| A × B × C | 0.240 | 1 | 0.11 | 0.735 |
| A × B × D | 7.30 | 1 | 6.07 | 0.018 |
| A × C × D | 0.187 | 1 | 0.17 | 0.680 |
| B × C × D | 6.00 | 1 | 4.92 | 0.032 |
| | | | | |
| A × B × C × D | 0.32 | 1 | 0.30 | 0.585 |
| | | | | |
| A × B × C × E | 3.58 | 1 | 1.73 | 0.195 |
| A × B × D × E | 3.12 | 1 | 2.59 | 0.115 |
| A × C × D × E | 1.11 | 1 | 1.03 | 0.316 |
| B × C × D × E | 0.26 | 1 | 0.21 | 0.644 |
| | | | | |
| A × B × C × D × E | 2.60 | 1 | 2.42 | 0.127 |
| | | | | |
| Error (A/within) | 490.83 | 42 | | |
| Error (B/within) | 53.20 | 42 | | |
| Error (C/within) | 71.64 | 42 | | |
| Error (D/within) | 97.50 | 42 | | |
| | | | | |
| Error (A × B/within) | 94.35 | 42 | | |
| Error (A × C/within) | 106.64 | 42 | | |
| Error (A × D/within) | 195.36 | 42 | | |
| Error (B × C/within) | 112.50 | 42 | | |
| Error (B × D/within) | 98,76 | 42 | | |

| | | |
|---|---|---|
| Error (C × D/within) | 50.09 | 42 |
| Error (A × B × C /within) | 84.87 | 42 |
| Error (A × B × D /within) | 49.34 | 42 |
| Error (A × C × D /within) | 44.42 | 42 |
| Error (B × C × D /within) | 50.03 | 42 |
| Error (A × B × C × D /within) | 44.11 | 42 |
| Error (A× E/between) | 490.83 | 42 |
| Error (B× E/between) | 53.20 | 42 |
| Error (C× E/between) | 71.64 | 42 |
| Error (D× E/between) | 97.50 | 42 |
| Error (A × B × E/between) | 94.35 | 42 |
| Error (A × C × E/between) | 106.64 | 42 |
| Error (A × D × E/between) | 195.36 | 42 |
| Error (B × C × E/between) | 112.50 | 42 |
| Error (B × D × E/between) | 98.76 | 42 |
| Error (C × D × E/between) | 50.09 | 42 |
| Error (A × B × C × E /between) | 84.87 | 42 |
| Error (A × B × D × E /between) | 49.34 | 42 |
| Error (A × C × D × E /between) | 44.34 | 42 |
| Error (B × C × D × E/between) | 50.03 | 42 |
| Error (A × B × C × D × E /between) | 44.11 | 42 |

Average errors when the white face (own-race) block appeared first, as a function of Trial Type, Race, Group and Orientation, Experiment 2.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | | | | |
| Same Trial | 0.63 (0.28) | 1.09 (0.37) | 1.22 (0.35) | 0.81 (0.37) |
| Different Trial | 2.13 (0.46) | 4.04 (0.57) | 1.13 (0.38) | 2.95 (0.52) |
| Other Race (Black) | | | | |
| Same Trial | 0.86 (0.31) | 1.00 (0.31) | 1.36 (0.37) | 1.54 (0.39) |
| Different Trial | 1.45 (0.30) | 2.00 (0.53) | 1.40 (0.30) | 2.13 (0.52) |

*Note*. Numbers in parentheses represent standard error.

Errors when the black (other-race) face block appeared first, as a function of Trial Type, Race, Group and Orientation, Experiment 2.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | | | | |
| Same Trial | 1.23 (0.29) | 1.76 (0.38) | 1.57 (0.34) | 1,71 (0.38) |
| Different Trial | 1.76 (0.47) | 4.19 (0.58) | 1.61 (0.39) | 2.81 (0.53) |
| Other Race (Black) | | | | |
| Same Trial | 1.14 (0.31) | 1.28 (0.32) | 2.14 (0.38) | 2.14 (0.40) |
| Different Trial | 1.90 (0.36) | 3.00 (0.54) | 1.33 (0.31) | 2.76 (0.53) |

*Note*. Numbers in parentheses represent standard error.

**Appendix G**

Correlations between self reported quality and quantity of contact and reaction time inversion costs for own and other-university other-race targets, Experiment 2.

| | Quantity of Contact | | Quality of Contact | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Own University (Birmingham) | -0.01 | 0.90 | 0.01 | .0.95 |
| Other University (Nottingham) | -0.01 | 0.98 | 0.12 | 0.42 |

**Appendix H**

**Interracial Contact Questionnaire (adapted from Hancock & Rhodes, 2008)**

In the following questionnaire we would like you to indicate how well the following statements represent the type of interactions you have with Black and Caucasian people. Please indicate the extent to which each statement represents your interactions by crossing out the number which best represents your opinion.

| Very strongly disagree | Strongly disagree | Disagree | Agree | Strongly Agree | Very Strongly Agree |
|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 |

(1) I know lots of Black people
(2) I interact with White people during recreational periods
(3) I live, or have lived in an area where I interact with Black people
(4) I live, or have lived in an area where I interact with White people
(5) I interact with Black people during recreational periods
(6) I interact with White people on a daily basis
(7) I socialize a lot with White people
(8) I went to a high school where I interacted with Black students
(9) I socialize a lot with Black people
(10) I know lots of White people
(11) I generally only interact with Black people
(12) I interact with Black people on a daily basis
(13) I went to a high school where I interacted with White students
(14) I generally only interact with White people
(15) I have lived in a country where the predominant race is Black

**Appendix I**

*ANOVA Summary: Experiment 3, Recognition Sensitivity (d')*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 6.66 | 1 | 6.20 | 0.019 |
| University (B) | 5.26 | 1 | 8.50 | 0.007 |
| A × B | 5.71 | 1 | 6.97 | 0.013 |
| Error (A/within) | 30.99 | 29 | | |
| Error (B/within) | 17.94 | 29 | | |
| Error (A × B/within) | 23.77 | 29 | | |

Average discrimination sensitivity (*d*) Scores, as a function of target race and group, Experiment 3.

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| Own Race (White) | 1.97 (0.10) | 1.11 (0.15) |
| Other Race (Black) | 1.06 (0.23) | 1.08 (0.12) |

*Note.* Numbers in parentheses represent standard error

**Appendix J**

*ANOVA Summary: Experiment 3, Criterion Bias (C)*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 7.80 | 1 | 24.362 | 0.001 |
| University (B) | 0.01 | 1 | 0.076 | 0.785 |
| A × B | 0.00 | 1 | 0.002 | 0.966 |
| Error (A/within) | 9.29 | 29 | | |
| Error (B/within) | 4.86 | 29 | | |
| Error (A × B/within) | 3.65 | 29 | | |

Average criterion bias (*C*) Scores, as a function of target race and group, Experiment 3.

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| Own Race (White) | 0.24 (0.62) | 0.26 (0.71) |
| Other Race (Black) | -0.26 (0.54) | -0.24 (0.93) |

*Note.* Numbers in parentheses represent standard error

**Appendix K**

*ANOVA Summary: Experiment 3, Confidence Ratings*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 2.23 | 1 | 10.292 | 0.003 |
| University (B) | 0.29 | 1 | 3.431 | 0.074 |
| A × B | 0.00 | 1 | 0.047 | 0.830 |
| Error (A/within) | 6.30 | 29 | | |
| Error (B/within) | 2.48 | 29 | | |
| Error (A × B/within) | 2.35 | 29 | | |

Average confidence ratings, as a function of target race and group, Experiment 3.

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| Own Race (White) | 4.85 (0.11) | 4.76 (0.13) |
| Other Race (Black) | 4.58 (0.13) | 4.47 (0.15) |

*Note.* Numbers in parentheses represent standard error

**Appendix L**

Correlations between self reported quantity of contact and recognition sensitivity (*d'*) for other-race targets, as a function of target race and group, Experiment 3.

| | Quantity of Contact | |
|---|---|---|
| | *r* | *p* |
| Own University (Birmingham) | -0.30 | 0.10 |
| Other University (Nottingham) | -0.09 | 0.63 |

Correlations between self reported quantity of contact and criterion bias (*C*) for other-race targets, as a function of target race and group, Experiment 3.

| | Quantity of Contact | |
|---|---|---|
| | *r* | *p* |
| Own University (Birmingham) | 0.21 | 0.14 |
| Other University (Nottingham) | 0.09 | 0.62 |

Correlations between self reported quantity of contact and confidence ratings for other-race targets, as a function of target race and group, Experiment 3.

| | Quantity of Contact | |
|---|---|---|
| | *r* | *p* |
| Own University (Birmingham) | 0.18 | 0.32 |
| Other University (Nottingham) | 0.23 | 0.21 |

**Appendix M** *ANOVA Summary: Experiment 4, Likeability Ratings*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 27.32 | 1 | 49.648 | 0.001 |
| University (B) | 0.79 | 1 | 3.568 | 0.043 |
| A × B | 0.40 | 1 | 2.941 | 0.099 |
| Error (A/within) | 13.76 | 25 | | |
| Error (B/within) | 4.36 | 25 | | |
| Error (A × B/within) | 2.043 | 25 | | |

Average likeability ratings, as a function of target race and group, Experiment 4.

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| Own Race (White) | 4.45 (0.12) | 4.17 (0.13) |
| Other Race (Black) | 3.32 (0.16) | 3.25 (0.16) |

*Note.* Numbers in parentheses represent standard error

**Appendix N**

*ANOVA Summary: Experiment 4, Encoding Response Times*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 2565.44 | 1 | 0.076 | 0.786 |
| University (B) | 8085.24 | 1 | 1.021 | 0.322 |
| A × B | 13208.72 | 1 | 0.805 | 0.378 |
| Error (A/within) | 847836.98 | 25 | | |
| Error (B/within) | 198030.36 | 25 | | |
| Error (A × B/within) | 410268.62 | 25 | | |

Average likeability response times (ms), as a function of target race and group, Experiment 4.

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| Own Race (White) | 1633 (104.46) | 1628 (97. 91) |
| Other Race (Black) | 1601 (102.22) | 1641 (100.70) |

*Note.* Numbers in parentheses represent standard error

**Appendix O**

*ANOVA Summary: Experiment 4, Recognition Sensitivity (d')*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 29.05 | 1 | 33.399 | 0.001 |
| University (B) | 4.82 | 1 | 7.409 | 0.012 |
| A × B | 2.71 | 1 | 4.565 | 0.043 |
| Error (A/within) | 21.74 | 25 | | |
| Error (B/within) | 16.26 | 25 | | |
| Error (A × B/within) | 14.86 | 25 | | |

Average discrimination sensitivity (*d')* scores, as a function of target race and group, Experiment 4.

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| Own Race (White) | 1.76 (0.10) | 1.65 (0.12) |
| Other Race (Black) | 1.03 (0.12) | 0.27 (0.24) |

*Note*. Numbers in parentheses represent standard error

**Appendix P**

*ANOVA Summary: Experiment 4, Criterion Bias (C)*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 19.51 | 1 | 27.544 | 0.001 |
| University (B) | 0.80 | 1 | 3.302 | 0.081 |
| A × B | 3.19 | 1 | 14.331 | 0.001 |
| Error (A/within) | 17.70 | 25 | | |
| Error (B/within) | 6.12 | 25 | | |
| Error (A × B/within) | 5.57 | 25 | | |

Average criterion bias (*C)* scores, as a function of target race and group, Experiment 4.

| | Own University (Birmingham) | Other University (Nottingham) |
|---|---|---|
| Own Race (White) | 0.18 (0.08) | 0.36 (0.83) |
| Other Race (Black) | 0.32 (0.09) | -0.85 (0.16) |

*Note.* Numbers in parentheses represent standard error

**Appendix Q**

Correlations between self reported quality and quantity of contact and discrimination sensitivity (*d'*) scores for own and other-university other-race targets, Experiment 4.

| | Quantity of Contact | | Quality of Contact | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Own University (Birmingham) | -0.01 | 0.94 | 0.07 | 0.72 |
| Other University (Nottingham) | 0.15 | 0.48 | 0.24 | 0.25 |

Correlations between self reported quality and quantity of contact and criterion bias scores (*C*) scores for own and other-university other-race targets, Experiment 4.

| | Quantity of Contact | | Quality of Contact | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Own University (Birmingham) | 0.01 | 0.97 | 0.18 | 0.38 |
| Other University (Nottingham) | -0.08 | 0.70 | -0.19 | 0.37 |

**Appendix R**

Correlation coefficients between likeability ratings and recognition sensitivity (*d'*) as a function of target race and university, Experiment 4.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Own Race (White) | 0.29 | 0.16 | 0.02 | 0.91 |
| Other Race (Black) | -0.04 | 0.84 | -0.19 | 0.34 |

**Appendix S**

Correlation coefficients between likeability response times and recognition sensitivity (*d*') as a function of target Race and University, Experiment 4.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Own Race (White) | 4.85 | 0.12 | 4.76 | 0.13 |
| Other Race (Black) | 4.58 | 0.13 | 4.48 | 0.15 |

**Appendix T**

*ANOVA Summary: Experiment 5, Recognition Sensitivity (d')*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 16.51 | 1 | 16.073 | 0.001 |
| University (B) | 0.15 | 1 | 0.152 | 0.699 |
| Orientation (C) | 0.06 | 1 | 0.059 | 0.810 |
| A × B | 9.49 | 1 | 23.759 | 0.001 |
| A × C | 0.78 | 1 | 1.055 | 0.311 |
| B × C | 3.56 | 1 | 3.862 | 0.058 |
| A × B × C | 4.024 | 1 | 5.430 | 0.025 |
| Error (A/within) | 39.04 | 38 | | |
| Error (B/within) | 38.73 | 38 | | |
| Error (C/within) | 38.95 | 38 | | |
| Error (A × B/within) | 9.49 | 38 | | |
| Error (A × C/within) | 28.31 | 38 | | |
| Error (B × C/within) | 35.37 | 38 | | |
| Error (A × B × C /within) | 28.16 | 38 | | |

Average recognition sensitivity (*d'*), as a function of target race, group and orientation, Experiment 5.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | 1.53 (0.13) | 1.47 (0.15) | 1.24 (0.14) | 1.15 (0.16) |
| Other Race (Black) | 0.85 (0.15) | 0.54 (0.15) | 0.80 (0.15) | 1.37 (0.15) |

*Note.* Numbers in parentheses represent standard error

**Appendix U**

*ANOVA Summary: Experiment 5, Criterion Bias (C)*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 7.47 | 1 | 15.142 | 0.001 |
| University (B) | 1.71 | 1 | 6.535 | 0.015 |
| Orientation (C) | 24.08 | 1 | 47.277 | 0.001 |
| A × B | 2.43 | 1 | 8.229 | 0.007 |
| A × C | 0.83 | 1 | 3.274 | 0.078 |
| B × C | 1.96 | 1 | 20.647 | 0.001 |
| A × B × C | 0.010 | 1 | 0.108 | 0.745 |
| Error (A/within) | 18.77 | 38 | | |
| Error (B/within) | 9.96 | 38 | | |
| Error (C/within) | 19.36 | 38 | | |
| Error (A × B/within) | 11.21 | 38 | | |
| Error (A × C/within) | 9.64 | 38 | | |
| Error (B × C/within) | 3.60 | 38 | | |
| Error (A × B × C /within) | 3.55 | 38 | | |

Average criterion bias scores as a function of target race, group and orientation, Experiment 5.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own-race (White) | 0.47 (0.07) | -0.13 (0.08) | 0.29 (0.08) | -0.01 (0.08) |
| Other-race (Black) | 0.10 (0.08) | -0.73 (0.09) | 0.25 (0.07) | -0.24 (0.09) |

*Note*. Numbers in parentheses denote standard error.

**Appendix V**

Correlation coefficients between the quality and quantity of other-race contact and discrimination sensitivity (*d'*) inversion costs for other-race faces as a function of target university, Experiment 5.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Quantity of Contact | 0.04 | 0.82 | 0.13 | 0.43 |
| Quality of Contact | -0.13 | 0.45 | 0.14 | 0.39 |

**Appendix W**

*ANOVA Summary: Experiment 6, likeability ratings*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 56.50 | 1 | 40.190 | 0.001 |
| University (B) | 2.65 | 1 | 11.554 | 0.002 |
| Orientation (C) | 0.10 | 1 | 0.266 | 0.609 |
| A × B | 0.006 | 1 | 0.038 | 0.847 |
| A × C | 0.132 | 1 | 0.829 | 0.368 |
| B × C | 0.860 | 1 | 5.775 | 0.021 |
| A × B × C | 0.011 | 1 | 0.060 | 0.0807 |
| Error (A/within) | 53.42 | 38 | | |
| Error (B/within) | 8.73 | 38 | | |
| Error (C/within) | 15.27 | 38 | | |
| Error (A × B/within) | 6.50 | 38 | | |
| Error (A × C/within) | 0.13 | 38 | | |
| Error (B × C/within) | 0.86 | 38 | | |
| Error (A × B × C /within) | 6.70 | 38 | | |

Likeability ratings as a function of target race, group and orientation, Experiment 6.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | 4.39 (0.13) | 4.30 (0.15) | 4.12 (0.14) | 4.22 (0.16) |
| Other Race (Black) | 3.60 (0.13) | 3.41 (0.15) | 3.29 (0.13) | 3.33 (0.14) |

*Note.* Numbers in parentheses represent standard error

**Appendix X**

*ANOVA Summary: Experiment 6, likeability response latencies*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 124751.60 | 1 | 0.883 | 0.353 |
| University (B) | 121344.00 | 1 | 1.573 | 0.217 |
| Orientation (C) | 791523.29 | 1 | 4.181 | 0.048 |
| A × B | 34676.39 | 1 | 0.311 | 0.580 |
| A × C | 29630.84 | 1 | 0.372 | 0.545 |
| B × C | 13706.73 | 1 | 0.262 | 0.621 |
| A × B × C | 5493 | 1 | 0.086 | 0.0771 |
| Error (A/within) | 5370965.34 | 38 | | |
| Error (B/within) | 3172293.59 | 38 | | |
| Error (C/within) | 7190998.20 | 38 | | |
| Error (A × B/within) | 4235619.42 | 38 | | |
| Error (A × C/within) | 3023164.56 | 38 | | |
| Error (B × C/within) | 1991227.92 | 38 | | |
| Error (A × B × C /within) | 2428994.83 | 38 | | |

Average likeability response latencies (ms), as a function of target race, group and orientation, Experiment 6.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | 2082 (125.53) | 2223 (107.65) | 2165 (127.54) | 2264 (125.20) |
| Other Race (Black) | 2170 (134.73) | 2257 (119.53) | 2195 (139.430) | 2272 (135.86) |

*Note.* Numbers in parentheses represent standard error

## Appendix Y

*ANOVA Summary: Experiment 6, discrimination sensitivity (d')*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 37.07 | 1 | 65.662 | 0.001 |
| University (B) | 2.82 | 1 | 4.141 | 0.049 |
| Orientation (C) | 9.46 | 1 | 7.368 | 0.019 |
| A × B | 6.08 | 1 | 8.966 | 0.005 |
| A × C | 0.023 | 1 | 0.037 | 0.848 |
| B × C | 0.72 | 1 | 1.403 | 0.244 |
| A × B × C | 2.97 | 1 | 4.273 | 0.046 |
| Error (A/within) | 21.45 | 38 | | |
| Error (B/within) | 25.91 | 38 | | |
| Error (C/within) | 48.84 | 38 | | |
| Error (A × B/within) | 25.77 | 38 | | |
| Error (A × C/within) | 23.809 | 38 | | |
| Error (B × C/within) | 19.616 | 38 | | |
| Error (A × B × C /within) | 26.43 | 38 | | |

Average discrimination sensitivity (*d'*), as a function of target race, group and orientation, Experiment 6.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | 1.76 (0.14) | 1.50 (0.15) | 1.77 (0.13) | 1.31 (0.14) |
| Other Race (Black) | 0.98 (0.13) | 0.35 (0.13) | 1.15 (0.182) | 1.11 (0.17) |

*Note.* Numbers in parentheses represent standard error

**Appendix Z**

*ANOVA Summary: Experiment 6, criterion bias (C)*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 20.68 | 1 | 38.239 | 0.001 |
| University (B) | 0.47 | 1 | 4.140 | 0.049 |
| Orientation (C) | 11.49 | 1 | 30.809 | 0.001 |
| A × B | 0.14 | 1 | 0.852 | 0.362 |
| A × C | 1.37 | 1 | 5.130 | 0.029 |
| B × C | 1.99 | 1 | 12.68 | 0.001 |
| A × B × C | 0.20 | 1 | 1.035 | 0.315 |
| Error (A/within) | 20.55 | 38 | | |
| Error (B/within) | 4.33 | 38 | | |
| Error (C/within) | 14.17 | 38 | | |
| Error (A × B/within) | 6.48 | 38 | | |
| Error (A × C/within) | 10.15 | 38 | | |
| Error (B × C/within) | 5.977 | 38 | | |
| Error (A × B × C /within) | 7.42 | 38 | | |

Average criterion bias (*C*), as a function of target race, group and orientation, Experiment 6.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| Own Race (White) | 0.70 (0.71) | 0.34 (0.96) | 0.62 (0.82) | 0.48 (0.75) |
| Other Race (Black) | 0.32 (0.96) | -400 (0.11) | 0.24 (0.93) | -0.68 (0.11) |

*Note*. Numbers in parentheses represent standard error

**Appendix AA**

Correlation coefficients between the quality and quantity of other-race contact and discrimination sensitivity (*d'*) inversion costs for other-race faces as a function of target university, Experiment 6.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | *r* | *p* | *r* | *p* |
| Quantity of Contact | -0.03 | 0.81 | 0.08 | 0.60 |
| Quality of Contact | 0.02 | 0.89 | 0.56 | 0.73 |

**Appendix BA**

*ANOVA Summary: Experiment 7, response latencies (ms)*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 6010.32 | 1 | 3.350 | 0.087 |
| University (B) | 0.202 | 1 | 0.001 | 0.984 |
| Orientation (C) | 59845.45 | 1 | 31.25 | 0.001 |
| A × B | 58.01 | 1 | 0.76 | 0.7.87 |
| A × C | 666.35 | 1 | 2.165 | 0.162 |
| B × C | 247.28 | 1 | 0.263 | 0.615 |
| A × B × C | 762.20 | 1 | 1.255 | 0.280 |
| Error (A/within) | 26913.29 | 15 | | |
| Error (B/within) | 7410.82 | 15 | | |
| Error (C/within) | 288720.85 | 15 | | |
| Error (A × B/within) | 11507.51 | 15 | | |
| Error (A × C/within) | 44617.21 | 15 | | |
| Error (B × C/within) | 14093.36 | 15 | | |
| Error (A × B × C /within) | 9110.57 | 15 | | |

*ANOVA Summary: Experiment 7, Error Analysis*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 5.69 | 1 | 8.768 | 0.010 |
| University (B) | 0.008 | 1 | 0.019 | 0.891 |
| Orientation (C) | 35.07 | 1 | 29.86 | 0.001 |
| A × B | 0.28 | 1 | 0.351 | 0.563 |
| A × C | 0.00 | 1 | 0.00 | 1.000 |
| B × C | 0.31 | 1 | 0.98 | 0.759 |
| A × B × C | 0.19 | 1 | 0.34 | 0.56 |
| Error (A/within) | 9.74 | 15 | | |
| Error (B/within) | 6.055 | 15 | | |
| Error (C/within) | 17.61 | 15 | | |
| Error (A × B/within) | 12.03 | 15 | | |
| Error (A × C/within) | 7.43 | 15 | | |
| Error (B × C/within) | 4.781 | 15 | | |
| Error (A × B × C /within) | 8.61 | 15 | | |

**Appendix CA**

*ANOVA Summary Table for P100 Mean Peak Latency, Experiment 7.*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Hemisphere (A) | 0.53 | 1 | 0.006 | 0.94 |
| Race (B) | 326.37 | 1 | 2.509 | 0.14 |
| University (C) | 21.51 | 1 | 0.262 | 0.62 |
| Orientation (D) | 214.57 | 1 | 0.239 | 0.24 |
| A × B | 2.15 | 1 | 0.038 | 0.85 |
| A × C | 50.13 | 1 | 1.361 | 0.26 |
| A × D | 40.29 | 1 | 1.628 | 0.22 |
| B × C | 200.50 | 1 | 3.647 | 0.08 |
| B × D | 37.26 | 1 | 0.430 | 0.52 |
| C × D | 149.01 | 1 | 2.507 | 0.13 |
| A × B × C | 19.31 | 1 | 0.609 | 0.45 |
| A × B × D | 50.13 | 1 | 2.084 | 0.17 |
| A × C × D | 34.34 | 1 | 0.614 | 0.45 |
| B × C × D | 167.43 | 1 | 0.829 | 0.38 |
| A × B × C × D | 21.52 | 1 | 1.073 | 0.31 |
| Error (A/within) | 1280.24 | 15 | | |
| Error (B/within) | 1950.99 | 15 | | |
| Error (C/within) | 1233.52 | 15 | | |
| Error (D/Within) | 2144.80 | 15 | | |
| Error (A × B/within) | 848.52 | 15 | | |
| Error (A × C/within) | 552.61 | 15 | | |
| Error (A × D/within) | 373.61 | 15 | | |
| Error (B × C/Within) | 824.71 | 15 | | |
| Error (B × D/within) | 1300.75 | 15 | | |
| Error (C × D/within) | 891.45 | 15 | | |
| Error (A × B × C/Within) | 475.67 | 15 | | |
| Error (A × B × D/Within) | 360.90 | 15 | | |
| Error (A × C × D/Within) | 838.30 | 15 | | |
| Error (B × C × D/Within) | 3031.21 | 15 | | |
| Error (A × B × C × D/Within) | 300.82 | 15 | | |

*ANOVA Summary Table for P100 Mean Peak Amplitude, Experiment 7*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Hemisphere (A) | 212.85 | 1 | 4.827 | 0.44 |
| Race (B) | 12.49 | 1 | 0.580 | 0.46 |
| University (C) | 1.30 | 1 | 0.221 | 0.65 |
| Orientation (D) | 133.78 | 1 | 22.283 | 0.001 |
| | | | | |
| A × B | 0.20 | 1 | 0.122 | 0.73 |
| A × C | 0.22 | 1 | 0.199 | 0.66 |
| A × D | 0.23 | 1 | 0.255 | 0.62 |
| B × C | 8.44 | 1 | 0.861 | 0.37 |
| B × D | 50.09 | 1 | 3.822 | 0.07 |
| C × D | 4.92 | 1 | 0.521 | 0.48 |
| | | | | |
| A × B × C | 0.97 | 1 | 0.302 | 0.59 |
| A × B × D | 1.66 | 1 | 0.521 | 0.48 |
| A × C × D | 3.57 | 1 | 1.93 | 0.19 |
| B × C × D | 7.77 | 1 | 0.933 | 0.35 |
| | | | | |
| A × B × C × D | 1.00 | 1 | 0.322 | 0.58 |
| | | | | |
| Error (A/within) | 661.42 | 15 | | |
| Error (B/within) | 323.13 | 15 | | |
| Error (C/within) | 88.12 | 15 | | |
| Error (D/Within) | 90.05 | 15 | | |
| | | | | |
| Error (A × B/within) | 24.78 | 15 | | |
| Error (A × C/within) | 16.82 | 15 | | |
| Error (A × D/within) | 13.60 | 15 | | |
| Error (B × C/Within) | 147.12 | 15 | | |
| Error (B × D/within) | 196.56 | 15 | | |
| Error (C × D/within) | 141.41 | 15 | | |
| | | | | |
| Error (A × B × C/Within) | 48.31 | 15 | | |
| Error (A × B × D/Within) | 29.20 | 15 | | |
| Error (A × C × D/Within) | 27.77 | 15 | | |
| Error (B × C × D/Within) | 124.94 | 15 | | |
| | | | | |
| Error (A × B × C × D/Within) | 46.66 | 15 | | |

*P100 Mean Peak Latency (ms) and Amplitude (µV) as a Function of Hemisphere, Race, University, and Orientation*

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| | | *Left Hemisphere* | | |
| Own Race (White) | | | | |
| P100 Latency (ms) | 109 (2.57) | 111 (4.58) | 107 (3.12) | 111 (2.53) |
| P100 Amplitude (µV) | 8.26 (1.02) | 10.93 (1.33) | 8.00 (1.24) | 9.80 (1.33) |
| Other Race (Black) | | | | |
| P100 Latency (ms) | 108 (3.40) | 114 (4.13) | 113 (3.08) | 112 (3.90) |
| P100 Amplitude (µV) | 9.47 (1.26) | 9.74 (1.39) | 9.24 (1.16) | 10.54 (1.45) |
| | | *Right Hemisphere* | | |
| Own Race (White) | | | | |
| P100 Latency (ms) | 109 (1.81) | 113 (2.98) | 107 (2.63) | 108 (3.24) |
| P100 Amplitude (µV) | 10.22 (1.13) | 12.36 (1.41) | 9.61 (1.51) | 12.33 (1.26) |
| Other Race (Black) | | | | |
| P100 Latency (ms) | 110 (3.14) | 113 (2.73) | 114 (2.32) | 110 (3.81) |
| P100 Amplitude (µV) | 11.63 (1.43) | 11.24 (1.56) | 11.06 (1.36) | 12.13 (1.70) |

*Note.* Numbers in parentheses represent standard error

**Appendix DA**

*ANOVA Summary Table for N170 Mean Peak Latency, Experiment 7.*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Hemisphere (A) | 7.881 | 1 | 0.164 | 0.692 |
| Race (B) | 2793.84 | 1 | 38.25 | 0.001 |
| University (C) | 27.55 | 1 | 0.258 | 0.619 |
| Orientation (D) | 2140.46 | 1 | 18.67 | 0.001 |
| A × B | 5.37 | 1 | 0.0340 | 0.568 |
| A × C | 0.37 | 1 | 0.28 | 0.869 |
| A × D | 1.20 | 1 | 0.077 | 0.785 |
| B × C | 45.07 | 1 | 0.028 | 0.869 |
| B × D | 134.48 | 1 | 0.1.017 | 0.329 |
| C × D | 358.00 | 1 | 5.028 | 0.40 |
| A × B × C | 0.134 | 1 | 0.010 | 0.92 |
| A × B × D | 14.32 | 1 | 2.007 | 0.177 |
| A × C × D | 3.35 | 1 | 0.472 | 0.503 |
| B × C × D | 177.03 | 1 | 5.955 | 0.028 |
| A × B × C × D | 2.51 | 1 | 0.352 | 0.562 |
| Error (A/within) | 722.89 | 15 | | |
| Error (B/within) | 1095.52 | 15 | | |
| Error (C/within) | 1599.64 | 15 | | |
| Error (D/Within) | 1719.35 | 15 | | |
| Error (A × B/within) | 237.09 | 15 | | |
| Error (A × C/within) | 198.221 | 15 | | |
| Error (A × D/within) | 234.59 | 15 | | |
| Error (B × C/Within) | 1790.01 | 15 | | |
| Error (B × D/within) | 1983.92 | 15 | | |
| Error (C × D/within) | 1068.00 | 15 | | |
| Error (A × B × C/Within) | 194.64 | 15 | | |
| Error (A × B × D/Within) | 107.03 | 15 | | |
| Error (A × C × D/Within) | 106.55 | 15 | | |
| Error (B × C × D/Within) | 445.92 | 15 | | |
| Error (A × B × C × D/Within) | 107.38 | 15 | | |

*ANOVA Summary Table for N170 Mean Peak Amplitude, Experiment 7*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Hemisphere (A) | 204.93 | 1 | 5.200 | 0.038 |
| Race (B) | 163.77 | 1 | 7.588 | 0.015 |
| University (C) | 4.87 | 1 | 0.486 | 0.496 |
| Orientation (D) | 28.04 | 1 | 1.695 | 0.213 |
| A × B | 17.39 | 1 | 6.772 | 0.020 |
| A × C | 0.19 | 1 | 0.119 | 0.734 |
| A × D | 0.015 | 1 | 0.009 | 0.927 |
| B × C | 169.86 | 1 | 6.634 | 0.021 |
| B × D | 6.26 | 1 | 0.34 | 0.561 |
| C × D | 0.80 | 1 | 0.047 | 0.832 |
| A × B × C | 0.151 | 1 | 0.0630 | 0.805 |
| A × B × D | 2.40 | 1 | 0.232 | 0.232 |
| A × C × D | 7.94 | 1 | 3.72 | 0.073 |
| B × C × D | 11.03 | 1 | 0.743 | 0.402 |
| A × B × C × D | 0.442 | 1 | 0.099 | 0.758 |
| Error (A/within) | 591.11 | 15 | | |
| Error (B/within) | 323,75 | 15 | | |
| Error (C/within) | 150.37 | 15 | | |
| Error (D/Within) | 248.20 | 15 | | |
| Error (A × B/within) | 38.53 | 15 | | |
| Error (A × C/within) | 25.04 | 15 | | |
| Error (A × D/within) | 25.02 | 15 | | |
| Error (B × C/Within) | 384.08 | 15 | | |
| Error (B × D/within) | 272.95 | 15 | | |
| Error (C × D/within) | 258.26 | 15 | | |
| Error (A × B × C/Within) | 35.98 | 15 | | |
| Error (A × B × D/Within) | 23.23 | 15 | | |
| Error (A × C × D/Within) | 31.97 | 15 | | |
| Error (B × C × D/Within) | 222.79 | 15 | | |
| Error (A × B × C × D/Within) | 67.19 | 15 | | |

*N170 Mean Peak Latency (ms) and Amplitude (µV) as a Function of Hemisphere, Race, University, and Orientation*

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| | | *Left Hemisphere* | | |
| Own Race (White) | | | | |
| N170 Latency (ms) | 156 (1.60) | 164 (3.09) | 156 (1.82) | 162 (2.93) |
| N170 Amplitude (µV) | -4.69 (1.02) | -5.09 (1.23) | -3.49 (1.33) | -3.37 (0.73) |
| Other Race (Black) | | | | |
| N170 Latency (ms) | 162 (2.08) | 171 (3.17) | 166 (2.77) | 167 (3.61) |
| N170 Amplitude (µV) | -4.08 (1.03) | -4.50 (1.29) | -5.24 (1.58) | -7.14 (1.35) |
| | | *Right Hemisphere* | | |
| Own Race (White) | | | | |
| N170 Latency (ms) | 157 (1.69) | 165 (2.65) | 156 (2.04) | 163 (2.54) |
| N170 Amplitude (µV) | -5.38 (1.42) | -6.73 (1.36) | -4.93 (1.46) | -4.69 (1.09) |
| Other Race (Black) | | | | |
| N170 Latency (ms) | 162 (1.96) | 170 (2.58) | 167 (2.39) | 166 (2.87) |
| N170 Amplitude (µV) | -6.13 (1.26) | -7.06 (1.67) | -8.18 (1.96) | -8.84 (1.87) |

*Note.* Numbers in parentheses represent standard error.

**Appendix EA**

*ANOVA Summary Table for P200 Mean Peak Latency, Experiment 7*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Hemisphere (A) | 493.58 | 1 | 5.875 | 0.02 |
| Race (B) | 1662.37 | 1 | 7.069 | 0.02 |
| University (C) | 1583.63 | 1 | 1.931 | 0.19 |
| Orientation (D) | 275.62 | 1 | 0.796 | 0.39 |
| A × B | 110.21 | 1 | 2.877 | 0.11 |
| A × C | 37.26 | 1 | 0.638 | 0.43 |
| A × D | 46.73 | 1 | 1.544 | 0.23 |
| B × C | 1323.25 | 1 | 1.237 | 0.28 |
| B × D | 400.78 | 1 | 2.631 | 0.13 |
| C × D | 2.15 | 1 | 0.009 | 0.93 |
| A × B × C | 120.70 | 1 | 1.884 | 0.19 |
| A × B × D | 40.29 | 1 | 1.705 | 0.21 |
| A × C × D | 34.33 | 1 | 0.700 | 0.42 |
| B × C × D | 229.12 | 1 | 0.414 | 0.53 |
| A × B × C × D | 0.95 | 1 | 0.027 | 0.87 |
| Error (A/within) | 1260.19 | 15 | | |
| Error (B/within) | 1662.37 | 15 | | |
| Error (C/within) | 12300.93 | 15 | | |
| Error (D/Within) | 275.62 | 15 | | |
| Error (A × B/within) | 110.21 | 15 | | |
| Error (A × C/within) | 875.39 | 15 | | |
| Error (A × D/within) | 453.96 | 15 | | |
| Error (B × C/Within) | 16039.35 | 15 | | |
| Error (B × D/within) | 2284.83 | 15 | | |
| Error (C × D/within) | 3563.64 | 15 | | |
| Error (A × B × C/Within) | 960.76 | 15 | | |
| Error (A × B × D/Within) | 354.54 | 15 | | |
| Error (A × C × D/Within) | 735.29 | 15 | | |
| Error (B × C × D/Within) | 8304.26 | 15 | | |
| Error (A × B × C × D/Within) | 538.83 | 15 | | |

*ANOVA Summary Table for P200 Mean Peak Amplitude, Experiment 7*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Hemisphere (A) | 172.50 | 1 | 6.882 | 0.02 |
| Race (B) | 78.88 | 1 | 4.047 | 0.06 |
| University (C) | 18.78 | 1 | 0.836 | 0.38 |
| Orientation (D) | 212.29 | 1 | 5.447 | 0.03 |
| A × B | 3.00 | 1 | 2.191 | 0.16 |
| A × C | 0.34 | 1 | 0.260 | 0.62 |
| A × D | 4.68 | 1 | 1.802 | 0.19 |
| B × C | 6.23 | 1 | 0.192 | 0.67 |
| B × D | 0.10 | 1 | 0.004 | 0.95 |
| C × D | 1.85 | 1 | 0.100 | 0.76 |
| A × B × C | 0.93 | 1 | 0.680 | 0.42 |
| A × B × D | 7.14 | 1 | 4.323 | 0.06 |
| A × C × D | 2.11 | 1 | 0.864 | 0.37 |
| B × C × D | 1.73 | 1 | 0.214 | 0.65 |
| A × B × C × D | 0.96 | 1 | 0.334 | 0.57 |
| Error (A/within) | 375.96 | 15 | | |
| Error (B/within) | 292.35 | 15 | | |
| Error (C/within) | 336.76 | 15 | | |
| Error (D/Within) | 584.65 | 15 | | |
| Error (A × B/within) | 20.57 | 15 | | |
| Error (A × C/within) | 19.39 | 15 | | |
| Error (A × D/within) | 38.94 | 15 | | |
| Error (B × C/Within) | 487.28 | 15 | | |
| Error (B × D/within) | 350.74 | 15 | | |
| Error (C × D/within) | 277.99 | 15 | | |
| Error (A × B × C/Within) | 20.41 | 15 | | |
| Error (A × B × D/Within) | 24.78 | 15 | | |
| Error (A × C × D/Within) | 36.66 | 15 | | |
| Error (B × C × D/Within) | 121.47 | 15 | | |
| Error (A × B × C × D/Within) | 43.00 | 15 | | |

*P200 Mean Peak Latency (ms) and Amplitude (µV) as a Function of Hemisphere, Race, University, and Orientation, Experiment 1*

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Upright | Inverted | Upright | Inverted |
| *Left Hemisphere* | | | | |
| Own Race (White) | | | | |
| P200 Latency (ms) | 211 (3.46) | 217 (5.15) | 214 (5.85) | 218 (3.02) |
| P200 Amplitude (µV) | 6.66 (1.16) | 5.12 (1.34) | 6.16 (1.34) | 4.01 (1.13) |
| Other Race (Black) | | | | |
| P200 Latency (ms) | 225 (9.18) | 223 (6.42) | 212 (4.74) | 215 (4.26) |
| P200 Amplitude (µV) | 5.14 (1.64) | 3.60 (0.96) | 4.44 (1.19) | 3.46 (1.18) |
| *Right Hemisphere* | | | | |
| Own Race (White) | | | | |
| P200 Latency (ms) | 214 (3.80) | 222 (4.43) | 214 (5.83) | 216 (2.12) |
| P200 Amplitude (µV) | 7.16 (1.07) | 5.76 (1.19) | 8.38 (1.21) | 6.35 (1.55) |
| Other Race (Black) | | | | |
| P200 Latency (ms) | 229 (8.62) | 226 (6.20) | 219 (5.93) | 218 (3.64) |
| P200 Amplitude (µV) | 7.46 (1.64) | 4.60 (1.07) | 7.03 (1.24) | 4.96 (1.15) |

*Note.* Numbers in parentheses represent standard error.

**Appendix FA**

*ANOVA Summary: Experiment 8, discrimination latency (ms)*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 1223.20 | 1 | 1.064 | 0.306 |
| University (B) | 771.39 | 1 | 0.845 | 0.361 |
| Alignment (C) | 142164.62 | 1 | 128.389 | 0.001 |
| A × B | 1787.18 | 1 | 1.375 | 0.245 |
| A × C | 661.14 | 1 | 0.740 | 3.93 |
| B × C | 5059.041 | 1 | 7.382 | 0.008 |
| A × B × C | 4965.25 | 1 | 4.312 | 0.042 |
| Error (A/within) | 72394.55 | 63 | | |
| Error (B/within) | 57503.89 | 63 | | |
| Error (C/within) | 69759.73 | 63 | | |
| Error (A × B/within) | 81888.56 | 63 | | |
| Error (A × C/within) | 56288.868 | 63 | | |
| Error (B × C/within) | 43172.88 | 63 | | |
| Error (A × B × C /within) | 7245.33 | 63 | | |

Average discrimination latency (ms), as a function of target race, group and orientation, Experiment 8.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Aligned | Misaligned | Aligned | Misalgined |
| Own Race (White) | 596 (13.38) | 560 (12.14) | 602 (12.82) | 566 (11.61) |
| Other Race (Black) | 607 (13.64) | 565 (12.02) | 593 (12.33) | 574 (12.39) |

*Note.* Numbers in parentheses represent standard error

## Appendix GA

*ANOVA Summary: Experiment 8, error analysis*

| Source | SS | df | F | p |
|---|---|---|---|---|
| Race (A) | 169.97 | 1 | 23.372 | 0.001 |
| University (B) | 0.56 | 1 | 0.142 | 0.708 |
| Alignement (C) | 710.17 | 1 | 37.270 | 0.001 |
| A × B | 0.096 | 1 | 0.026 | 0.873 |
| A × C | 62.58 | 1 | 22.20 | 0.001 |
| B × C | 2.67 | 1 | 1.063 | 0.306 |
| A × B × C | 0.330 | 1 | 0.128 | 0.722 |
| Error (A/within) | 458.15 | 63 | | |
| Error (B/within) | 250.56 | 63 | | |
| Error (C/within) | 1200.45 | 63 | | |
| Error (A × B/within) | 234.52 | 63 | | |
| Error (A × C/within) | 177.54 | 63 | | |
| Error (B × C/within) | 158.45 | 63 | | |
| Error (A × B × C /within) | 162.29 | 63 | | |

Average errors, as a function of target race, group and orientation, Experiment 8.

| | Own University (Birmingham) | | Other University (Nottingham) | |
|---|---|---|---|---|
| | Aligned | Misaligned | Aligned | Misaglied |
| Own Race (White) | 4.35 (0.64) | 2.60 (0.63) | 4.17 (0.66) | 2.60 (0.58) |
| Other Race (Black) | 6.23 (0.70) | 2.98 (0.59) | 6.00 (0.69) | 3.14 (0.59) |

*Note.* Numbers in parentheses represent standard error